SCIENCE

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*THE DEVELOPMENT OF CHEMISTRY.**

THE American Chemical Society exists for the advancement of chemical science, and the betterment of the chemical profession. Every member of it is supposed to contribute his share of thought and energy to the accomplishment of these ends; and so its work is prosecuted along many lines of activity. During the past ten years the growth of the Society has been most remarkable, and the diversity of its interests is well shown in the pages of its *Journal.* The once doubtful experiment of organization has justified itself by success, and there are no longer any apprehensions as to the future. The Society now stands before the world well established, well recognized, active and vigorous; its days of weakness and danger are over; we can look forward with confidence to greater prosperity, to larger growth, to steadily increasing usefulness. All chemistry is our province, whether it be organic, inorganic, theoretical, physical or applied; and the narrowness of specialism finds its best antidote in the varied interests of our meetings. To promote science and to uphold the dignity of our common profession are the objects which bind us together.

Optimism is a good thing, but it needs to

* Presidential address delivered at the Philadelphia meeting of the American Chemical Society, December 30, 1901.

be tempered by reason. Hopefulness and enthusiasm are fine qualities, but the restraint of common sense should keep them within bounds. Too much complacency is dangerous, and on occasions like this we may well pause in our gratulations over past achievements, to ask ourselves whither we are tending. As chemists, we owe something to the science which we represent, and the debt is one which can never be discharged absolutely. That we have done much is evidence that we can and should do more; as a society and as individuals we may well look about us and strive to see which way the path of duty lies. We cannot appraise the future, but we must help to make it. Only by acting with intelligent forethought can we hope to advance creditably.

Retrospection is the one safe basis for prophecy. The history of science is full of suggestions for the days to come, and even if we do no more than to avoid the repetition of mistakes, we shall gain much from the study. Great as the past has been, we can make sure of something better still, looking confidently forward to more perfect knowledge, to larger opportunities for research and to wider recognition in the republic of learning. Let us see how chemistry has developed hitherto, and how we can improve her present condition.

A little over a century ago chemistry was hardly more than an empirical art—a minor department in the broad field of natural philosophy. There were no chemists in the professional sense of the term, and no laboratories worthy of the name; that is, no buildings were planned and erected for chemical purposes alone; but chemical investigations were conducted in any room which happened to be available, with a disregard for convenience which would be intolerable to-day. Even at a later period the marvelous researches of Berzelius were performed in a laboratory which was essentially a kitchen. If we use the word in its true sense, the earlier chemists were amateurs; that is to say, men who labored for the love of truth and without ulterior professional motives. Priestley was a clergyman, who regarded his voluminous theological writings as more important than his contributions to science. Scheele was an apothecary; Lavoisier was a public official with multifarious duties; Dalton was a schoolmaster and arithmetician. Before these men and their contemporaries, a vast unexplored territory was outspread; and no one could suspect what hidden riches might lie beneath its surface. Lavoisier, with his emphasis upon quantitative methods; Dalton, with the atomic theory; Davy, the discoverer and definer of elements; and Berzelius, with his genius for system and his untiring industry in the accumulation of details, opened the main roads into the new empire. Specialism in chemistry was practically unknown; all portions of its domain seemed to be equally inviting; but inorganic problems were perhaps the most obvious, and, being easiest to grasp, received the greater share of attention.

There were, from the beginning, two great stimuli to chemical research; the intellectual interest of the problems to be solved, and the practical utility of many discoveries. Both forces were essential to the rapid development of our science; neither one alone would have been adequately effective. Economic considerations, taken by themselves, help but little towards the symmetrical organization of scientific knowledge, for the practical man has usually a limited, although very direct, purpose in view, and may not wander far from his main issue. On the other hand, the purely scientific investigator can rarely exercise his full powers without a certain measure of popular support and encouragement, to which the expectation of useful-

ness contributes. That discovery must precede application is obvious; that systematic knowledge outranks empiricism is also clearly true; but theory and practice react upon each other, and it is only when they work harmoniously side by side that the best results are attainable. The purist in science too often overlooks this fact, and fails to recognize his enormous debt to industry. The commercial demand for chemical data was an important factor in the establishment of our profession, and from it we derive a large part of our resources. At bottom, however, the demand is essentially selfish; and the manufacturer who seeks chemical aid, nay, even the technical chemist himself, is not uncommonly forgetful of his obligations to pure research. Every chemical occupation is based upon discoveries which were made without thought of material profit, and which sprang from investigations undertaken in the interests of truth alone. Even theory, which the ignorant worker affects to despise, has its place in the economic world, and the indebtedness of the coal-tar industry to Kekulé can hardly be overestimated. Without theory science is impossible; we should have, instead, only a chaotic anarchy of disconnected facts, a body without a soul. Theory is to science what discipline is to an army; it implies system, method and the intelligent direction of affairs; it is the coordination of knowledge, through which the experience of others becomes best available to us. The victories of research are rarely accidental; if they were, then the untrained tyro would have an equal chance of success with the greatest masters. Among ourselves, these considerations may be commonplace, but they are opposed by certain popular misconceptions which hinder our advancement and work mischief to our cause. *Cui bono* is the one question which science cannot ask.

Four agencies have been chiefly instrumental in building up the chemical structure of to-day, namely, private enterprise, the commercial demand, governmental requirements, and the extension of scientific teaching in the universities. Under the first of these headings the foundations of chemistry were laid, and the researches of Cavendish upon the composition of the atmosphere, may be taken as types of the class. Unfortunately, however, the men who combine the requisites of wealth, leisure, the inclination and the ability for scientific investigation are few in number, and the output of their labors is relatively small. Still, we must admit that the work so accomplished is often far above the average in quality, and that if it were to cease, our science would be much the poorer. Its motive is always high, and unaffected by any annoying pressure from necessity; its objects are purely scientific.

Seen from the commercial side, chemistry presents quite another aspect. Questions of utility are now paramount, and the advancement of science as such has become a secondary affair. The manufacturer seeks to improve his products or to cheapen his processes, and calls for information which shall enable him to do so; specific industrial problems require immediate attention, and each one is taken by itself, regardless of its broader philosophical bearings. From these conditions a certain narrowness must follow; no time can be wasted over considerations not directly related to the matters in hand, for the success or failure of a great enterprise may depend upon the quickness with which the obviously essential work is done. As against this urgency of demand, no just criticism can be offered; we may only ask that it shall be reasonable, and that science shall be treated less as a servant, and more as a faithful ally. The commercial chemist owes something to his profession,

as well as to his employer; and his industrial duties ought not to be incompatible with his responsibilities as a scientific man. The education of the manufacturer is one of the functions which he has to perform, and it is one which is not always easy of accomplishment. Two points of view have to be reconciled; self-interest is on the one side, the benefit of science on the other.

Several difficulties beset the pathway of applied science, and interfere with the work of its practitioners. The limitations of the field have already been suggested; but a more serious obstacle to progress is found in the secretiveness of the employer. The industrial chemist can not publish his researches, or at best can publish little; he therefore fails to receive before the world the credit which is his due, and science as a whole is the loser. A secret process, an unpublished investigation, adds nothing to the sum of human knowledge, and it represents a policy which is both short-sighted and unwise. It often covers ground which has been well covered before, and in that case it stands for misdirected effort, for wasted energy. I have seen, under the seal of confidence, a 'secret process' which had been in print for twenty years; its too practical inventor, ignorant of the literature of his subject, had worked out his methods independently; had he consulted others, he might have saved both expense and time. On still broader grounds I believe we may claim that the publicity of science is more economical than the current exclusiveness. Where several competing establishments produce the same class of goods, each one tries to hide its workings from the others. Each, therefore, gains only that new knowledge which it can develop by itself, whereas with greater wisdom it might profit by the experience of all. Secrets will leak out, in spite of precautions; a full interchange of thought merely anticipates the danger, and at last the manufacturer may find that instead of suffering loss, he has really received much for little. Possibly the combination of industries under the so-called 'trusts' may act favorably upon scientific research, for when rivalry ceases, the incentive to secrecy disappears also.

If we study the reaction between science and industry at all closely, I think we shall find that an economic revolution of remarkable importance is well under way. Like all the greater social movements, it is going on quietly, without noise or bluster, but it is nevertheless far-reaching in its effects. Manufacturing, once a matter of empirical judgment and individual skill, is more and more becoming an aggregation of scientific processes, a system in which accurate quantitative methods are replacing the old rules of thumb. Exact weight and measure are taking the place of guesswork, and by their means waste is diminished and economy of production is insured. I can remember the day when few establishments in America gave regular employment to chemists; now laboratories are maintained in connection with nearly all productive enterprises, and the demand for scientific service, which was formerly sporadic, has become well-nigh universal. A railway system, making contracts for supplies, does so upon the basis of chemical reports; and the work is performed in its own offices by experts who are permanently retained. In the management of an iron furnace, ore, flux, fuel and product are analyzed from day to day, by methods of amazing rapidity and considerable exactness. Fertilizers are sold upon chemical certificate after preparation under chemical rules; sugar is refined by chemical processes, and taxed according to chemical standards; medicine is enriched by new remedies of chemical origin; in short, our science touches every productive industry at many points, and aids in its transformation. Metallurgy is becoming more and

more a chemical art; photography, a modern science, rests upon chemical foundations; with the aid of the electric furnace new chemical industries are springing into existence; and every one of these agencies reacts upon the chemist, by increasing the demand for his services and his wares. In Germany this development of applied science has gone the farthest; and in that country a single establishment may employ from fifty to more than a hundred chemists in its regular work. Some of these men are analysts merely, but others are engaged in systematic research, which has both science and industry in view. This appreciation of research as such is something to which few of our American manufacturers have attained; and it marks the highest step yet taken in the line of industrial progress. The modern era began when hand labor, which means individualism, gave way to machinery; but the machine is a symbol of organized intellectual power, and science is the bed-rock of its foundation. Chance and supposition are out of place in the industrial world of to-day.

Turning now to the governmental side of science, we find that the services of the chemist are everywhere in demand. Every civilized government now maintains chemical laboratories, and for purposes of the most varied kind. The accuracy of the coinage is determined by the assayer; supplies for public use are tested by analytical methods; taxes are assessed in terms which need chemical interpretation; the armor of the battleship and the explosive of the torpedo depend for their efficiency upon the skill with which our work is done. The sanitation of cities; their water supply; the disposal of sewage; the effectiveness of antiseptics; the quality of gas for lighting or of asphalt for paving; the warfare against the adulteration of food—all of these questions are essentially chemical in character, and are, or should be, settled in the official laboratory. The aggregate of this work is something enormous; and yet, like commercial chemistry, it has utility, not science, in view. Science may advance because of it, but that is not the main purpose; the application of existing knowledge to public uses, and the creation of new knowledge are two distinct things. Here again chemistry is a servant, nothing more.

Throughout the scientific bureaus of the government this secondary character of chemistry appears. In the Geological Survey it is an aid to geology; in the Department of Agriculture, agriculture is to be advanced; in the medical service of the army or the navy, the interests of medicine come first. Chemistry for its own sake has as yet little or no governmental support; astronomy is encouraged, geology receives assistance, the biological sciences are given opportunities for growth; but our profession is merely utilized, without thought of its significance, its laborers being too often overworked and underpaid.

In an incidental way, however, the governmental laboratories accomplish something for pure science, albeit with little direct encouragement and in spite of difficulties. The official chemist, unlike his commercial brother, is not always crowded for time; his work can be done in a somewhat more leisurely manner, for it is unaffected by any demand for immediate financial returns; and so abstract researches, if they bear in any way upon the problems which are assigned him, are sometimes within his reach. Chemistry owes much to investigations of this class; and the papers which issue from official laboratories are by no means to be despised. Good work is done, but there ought to be more of it; research should become a recognized duty, rather than an employment for spare time. It would be well if every government could be made to see that the use of science implies the encouragement of

science; for then we might hope for the establishment of laboratories for purposes of investigation alone. To this proposition I shall recur later.

We now come to the fourth of the agencies by which chemistry has been developed, the educational, and this is the most important of all. Scientific research has become a definite function of the modern university, wherein the creation of knowledge is given equal rank with the distribution thereof. Education to-day differs from the education of former times, in that a lower place is given to mere authority; it goes more to the foundation of things, and so secures a foothold from which it can build much higher. Research, both for its own sake and as an example to the student, is now expected of the teacher; his pupils, coming face to face with the limitations of knowledge, are shown the problems which demand solution, and are taught something, by practice and by precept, of the manner in which they can be solved. The student learns that science is a living growth, and that every earnest, sincere, well-trained scholar can do something towards its development. If we examine the chemical journals of the nineteenth century, we shall find that by far the larger part of the discoveries therein recorded were made in the laboratories of universities or schools. Even in our own journal, with all its contributions from technical and official sources, over sixty per cent. of the communications published are of this class. The significance of this fact, however, must not be overestimated; we should remember the restrictions under which the technical chemist labors, whereas to the university professor publication is almost as the breath of life. His professional standing, his chances of promotion, are profoundly affected by the amount and character of the work which he puts forth; silence, to him, means the possible reproach of inactivity; he must publish or remain obscure. Furthermore, we must not forget that the teacher owes a debt to technology which can never be repaid. The commercial demand for applications of science has enlarged the field of education, by compelling the establishment of polytechnic schools. These institutions, all of them of recent date, give employment to thousands of instructors; they supplement the universities, they multiply the facilities for scientific work, and from them, too, there flows a steady stream of contributions to knowledge, to which the chemist is adding his full share.

Apart from the freedom to publish, the university teacher has one great advantage over the technical man. He is not confined to any limited field of operations, such as the chemistry of soap, or iron, or coal-tar; the whole domain of the science lies open before him to explore where he will. The possible utility of the work need not occupy his mind; he can attack any problem he chooses, and from any point of view. And yet, with all incentives to breadth, his researches may still be tainted with narrowness, for the inevitable tendency to specialize puts its restrictions upon him. It is much easier to be a physical chemist, an organic chemist, an agricultural chemist or an analyst, than it is to be a chemist; and chemists, in the larger sense, are few. It was Berzelius, I think, who said that he was the last man who could ever know all chemistry, and the saying was both wise and true. Sixty years ago our science could be mastered in its entirety by one industrious student; to-day it is so vast that subdivision is necessary. Still, special research is not incompatible with breadth of view; every chemist should understand the nature of the great central problems; he should stand high enough to overlook the field, no matter how small a corner of it he may prefer to cultivate per-

sonally. Broadness of mind does not imply a scattering of resources, a futile waste of opportunity; it means an intelligent appreciation of all good scientific work, whether it be within our own bailiwick or elsewhere. To exalt one specialty at the expense of others, to claim supremacy for our own small interests, indicates a self-conceit which is both mischievous and absurd.

With so many opportunities for research, and with numberless problems in sight, chemistry should have grown according to some law of symmetry, giving us to-day a well-balanced and harmonious whole. History, however, tells a different tale. The science has expanded enormously in some directions, and advanced slowly in others; a glaring disproportion is the result. For this condition of affairs there are two reasons: lack of coordinated labor and the influence of fashion; for there are fashions in thinking, just as there are in dress, and only the most original minds can escape from their domination. Theoretically, every investigator is free to follow his own bent; practically, his course is shaped by a complexity of circumstances. The line of least resistance is the easiest line to take, and in science that is determined by temporary conditions. Certain researches have been fruitful; and so, like miners flocking to a new camp, we are tempted to enter the same field, rather than to play the pioneer elsewhere. The greatest prospect of immediate success is the power which attracts us. Through influences of this kind chemistry has developed unevenly, with one side over-cultivated and another suffering from neglect.

To illustrate my meaning. I do not wish to underrate the importance of organic chemistry, nor to question, in the smallest degree, the value of its achievements. Its interest, its attractiveness, the beauty of its methods, its profound influence upon chemical theory, are all admitted; and yet it has received, it seems to me, an undue share of attention. During fifty years a large majority of all chemical investigators devoted themselves to this one branch of chemistry, leaving only a few workers to occupy other fields. Organic chemistry was the fashion; in it reputations were easiest made; the great professional prizes, the best positions, went to its devotees.

Now, in spite of all that organic chemistry has accomplished, we may fairly admit that chemical research should have a broader scope. Carbon is but one element among many; and all must be considered before we can be sure that our interpretations of chemical phenomena are sound. Special cases are easily mistaken for general laws; and to such errors we become liable when we confine our studies within too narrow bounds. Fortunately for chemistry, a broadening process has begun; and the prospects for the future are most encouraging.

During the past ten or fifteen years two movements have gained headway in the chemical world. One is marked by the revival of interest in inorganic problems, the other by the development of physico-chemical research. To a certain extent the two have much in common; each one is aided, I might say fertilized, by conceptions borrowed from the organic field; both are already fruitful to a remarkable degree. Independent journals devoted entirely to inorganic or physical chemistry, have come into existence, and investigators of the highest rank fill them with contributions. It is not my purpose to discuss either movement in detail; I mention them as symptoms of a more liberal spirit in research, as indicating the commencement of a new era. Physical chemistry in particular is becoming the center of interest; laboratories are built and equipped for its benefit alone; it bids fair to surpass even organic chemistry in

its dominion over chemical thought. One danger, however, confronts it—the danger of self-exaggeration, stimulated by over-popularity. Physical chemistry, to achieve the best results, has need of data drawn from other lines of chemical research; if they are neglected, it in turn will suffer. Even now too large a proportion of its votaries are working in one field; that is, on questions growing out of the current theory of solutions, and other subjects fail to receive the attention which they deserve. This state of affairs, this lack of proportion, is doubtless only temporary, for towards physical chemistry all chemical theories converge, and no phase of it, therefore, can long escape consideration. The very nature of physical chemistry implies the prohibition of narrowness; broad conceptions and deep insight are essential to its being.

When we consider the complex influences, the varied demands, through which chemistry has developed hitherto, we can only wonder at the outcome. Under the circumstances, a symmetrical growth was impossible; the marvel is that so much could have been accomplished. Out of unorganized, uncoordinated, individual efforts a true science has come into existence, equal in dignity to any other within the domain of learning. All science is defective, but in its very imperfections we find its greatest charm. Through them alone effort becomes possible; a wise discontent on our part is the first condition for progress. If all were known, research would come to an end; nothing could arouse our curiosity; the human mind would atrophy for want of exercise. The search for truth is better than the truth itself—if I may be allowed thus to paraphrase the well-known words of Lessing. In what direction, then, shall we pursue our search, and with what promise for the future? What are the needs of chemistry?

Pardon me, now, if I apparently indulge in commonplace; if I cite some considerations of almost alphabetic simplicity. Fundamental principles lie so close to our eyes that they are easily overlooked; and from negligence of that kind, misdirected effort may follow. We must review our lessons sometimes in order to make sure of what we really know. In the first place it is well to bear in mind that chemistry and physics are not sharply distinct; that they are two parts of the same great body of truth; and that neither can be studied to the best advantage without aid from the other. Both rest upon the same two basic doctrines—the conservation of energy and the persistence of matter—conceptions which supplement each other and which give our work its philosophical validity.

If we try to consider chemistry by itself, to conceive of it as an independent branch of learning, we shall find that it has but one fundamental problem, namely, the study of chemical reactions. From certain kinds of matter certain other kinds are produced; and we merely investigate the laws which govern the transformations. If we prepare new compounds, we discover that such and such reactions are possible, and we describe their products. If we are interested in chemical equilibrium, we seek to determine the limits between which a given change can occur. Even our notions of chemical structure and atomic linking are but devices through which reactions and their products may be coordinated. In every case the reaction is the ultimate object of purely chemical research, and we try to ascertain its laws. Beyond this we enter the realm of physics; we describe each kind of matter in thermal, optical, electrical, mechanical and gravitational terms, and we discuss the phenomena of chemical change in similar phraseology.

Let us take, for example, any reaction whatever, and see what its *complete* investigation signifies. At once the problem will

resolve itself into four parts, two statical and two dynamical, not one of which can logically be neglected. First, there are the substances which enter into the reaction; secondly, the physical stimulus, thermal, electrical or actinic, which starts the reaction; thirdly, the phenomena which occur during the reaction; and finally, the substances produced by the reaction. An initial state of equilibrium is disturbed by some application of energy; transformations of energy take place, and in a final state of equilibrium the process comes to an end. Through a mixture of gases having certain physical properties we pass an electric spark; they unite to form a liquid with different physical properties, the process being attended by a change of volume and great evolution of heat. The fact of union is chemical; the other phenomena are physical; and the two sets of considerations are so interlaced that we are compelled to take them together. Intellectually we can discriminate between them, but the line of demarcation is essentially ideal. The chemical composition of matter cannot be studied apart from its physical relations, nor discussed without the aid of physical terminology.

It is easier to preach than to practice; to say what should be done than to do it. Between the theoretical statement of a problem and the practical method by which it may be solved there is a profound gulf, over which a direct passage is perhaps impossible. No reaction has yet been exhaustively studied on the lines which I have laid down, and possibly none ever will be, for the difficulties in the way of such a research are almost insuperable. Of all the snares which nature sets before our unwary feet, that of apparent simplicity is the most deceptive. Honest complexity, evident at sight, we may hope to overcome; it is the unseen obstacle which baffles us. In the present instance a prime difficulty is the definition, the isolation of a reaction by itself, apart from other chemical changes. Nearly every reaction which we can observe is, in reality, a complex of several reactions—a series of steps, some of which may easily escape our notice. We measure certain phenomena, only to find at last that our result is an algebraic sum, and that we have more unknown quantities than equations. We cannot solve our problem until these factors have been recognized and separated.

To study individual reactions, then, except for the determination of definite, special phases, is not the best mode of procedure; chemistry would advance but slowly were we restricted to such a method. In ordinary chemical research, in the work of the compound-maker, for example, the initial and final stages of a series of reactions are investigated, and in that way valuable data are obtained. But the aim of science is not so much to amass facts as to connect them by laws and principles; and the more general the latter become, the greater is their intellectual value. We can not build, of course, until we have the materials, but between brick-making and architecture the difference is great indeed.

Leaving now the apparently simple, and turning to the visibly complex, let us see whether we cannot attack all reactions collectively, and in that way reach a more general statement of our real experimental problems. All reactions display the same fundamental phenomena, namely, changes of composition, changes of properties and transformations of energy; if we can classify our data under these categories, we shall begin to see more clearly the road we are to follow.

Now, recurring for a moment to the analysis of a single reaction, we may consider its two statical terms, the nature of the substances with which we begin and end. In any particular instance these ques-

tions are special and limited; but through them we discover facts which may be grouped with others of like kind. Presently we shall reach the discrimination between elements and compounds; and sooner or later we shall find ourselves face to face with one of the ultimate problems of all science—the nature of matter itself. In this problem all questions of chemical composition come to a focus; it goes back of the reaction to the substances which react; but it belongs equally to physics, and its essential details admit of description only in physical terms. Chemistry, however, is doing the most towards its solution, for it is through chemical researches that variations in the composition of matter are best explained. The indebtedness of chemistry to physics is thus fully repaid.

What is matter? Is it continuous or discrete, atomic or made up of vortex rings in the ether? These questions admit of only partial answers, and doubtless their final solution is unattainable by man. They are, nevertheless, perfectly legitimate questions for science to ask; and a tentative reply, of great practical value, is given by the atomic theory. Whether it be true or false, whether the chemical atoms are ultimate or divisible, this doctrine is the connecting thread upon which our profoundest generalizations are strung, and it is hard to see how we could do without it. Once a mere speculation of philosophy, Dalton gave it quantitative meaning; and from his day to the present every great advance in chemical theory has found its clearest statement in atomic terms. Chemical equations and formulæ; the laws which correlate the density of a gas with its composition; the law of Dulong and Petit; our ideas of valency and molecular structure; the periodic law; and the relations of stereochemistry, are all connected by the atomic theory, whose retention in science is therefore fully justified. It may not be beyond criticism; indeed, it should be criticized; but it would be the utmost folly to abandon the theory before something better has been framed to take its place. Vague and unsatisfactory are the attempts which have so far been made to supplant it. Physics, unaided by chemistry, may reach the conception of molecules; but the subdivision of the latter, the identification of their parts, is the function of the chemist alone.

If the nature of matter is the first element in the study of chemical reactions, the nature of chemical union is the second. If combination consists in a juxtaposition of atoms, what is the force which draws and holds them together? Whether we can answer this question or not, we may investigate the laws under which chemical action is operative, and so develop an important portion of physical chemistry. Problems of chemical equilibrium, of limiting conditions, of affinity and the speed of reactions, all come under this heading, and these are fit subjects for investigation in the laboratory. For instance, chemical action is impossible at very low temperatures, and at sufficiently high temperatures all compounds dissociate; each reaction, therefore, is confined to a certain part of the thermometric scale, which in many cases is measurable. In other words, chemical change is a function of temperature, no matter what additional factors its complete study may involve. It may also be effected through the agency of electrical or actinic impulses; and here again experimental research has a wide field. Were physical chemistry restricted, as it is not, to this class of investigations alone, it would still have abundant occupation. These illustrations are enough for my immediate purpose, but they could be multiplied indefinitely.

Directly growing out of these two fundamental questions, and partly identifiable with them, are two other problems of great

generality and importance. First, what laws connect the properties of compounds with their composition? Secondly, what laws govern the transformations of energy during chemical change? Along each of these lines a large amount of work has been done, mostly empirical; and some regularities, some minor laws, are already recognized. Systematically, however, neither field is well known, and both offer rich prizes to the investigator. Great masses of more or less available data now exist; but rarely do we find any group adequately developed. The determination of constants or the measurement of thermochemical relations is tedious in the extreme; but a vast amount of such work needs to be done under some definite system or plan. At present we have a datum here and a datum there; some one in Germany makes a few measurements, some one in France, or England, or America makes a few more; but seldom is there any attempt at cooperation, and the isolated facts do not always fit together. The thermochemical data are especially difficult to determine accurately, and still more difficult to discuss in such a way as to develop any clearly defined law. Indeed, thermochemistry, of late years, has fallen out of favor; for to many chemists, despite its promise, it seems to lead nowhere. But laws must exist under all these troubling questions, and we cannot despair of their discovery. We can accomplish little, however, unless we consider each of the four great fundamental problems with reference to the others, for they are separable only in theory. Scientific research is not linear, step following step in regular succession; it is a network, rather, whose interlacing threads are woven into patterns of infinite variety. We trace individual fibers, we see, more or less clearly, a part of the design; and this is the most that any one of us can ever hope to do.

Now, whether we regard the fundamental questions of chemistry as four in number, or condense them into two, we can use our classification as an aid to research. Success in the latter means a wise selection of problems, a choice which is conditioned by our strength and our resources; but the first step is to understand the bearings of what we are trying to do. Whether our purposes are modest or ambitious, our work must have an influence upon that of others, and the broader the plan upon which it is conceived, the better the outcome will be. One bullet well aimed is worth more than a volley at random. One fact with a purpose outweighs a hundred scattering observations. We may well ask, therefore, what investigations are most needed by chemistry to-day?

First, as to the nature of matter, with all that that question implies. Taking all kinds of matter into consideration, and starting with the established distinction between elements and compounds, it would seem to be obvious that work is most imperatively needed where our information is least complete. Some elements, some classes of compounds, have been much more exhaustively studied than others; they, therefore, can best bear a temporary neglect, our attention, in the meanwhile, being concentrated elsewhere. I do not mean by this that any kind of research should cease, only that each department should assume something like reasonable proportions. To organic chemistry, for example, we are indebted for many methods of research, and for theoretical conceptions of great fertility; but it is now time to apply them to inorganic substances, and to see whether they are generally valid. Whatever result is reached, organic chemistry itself will be the gainer; enriched by new suggestions and resting upon firmer foundations, its future advancement can be made all the more certain. Meanwhile, carbon compounds, by virtue of their serial relations,

are of peculiar value in certain lines of physico-chemical investigations; and they may also be profitably studied along the vague boundary which separates organic from inorganic chemistry. What we may call the contact phenomena between any two departments of knowledge are always interesting.

In the present revival of inorganic chemistry, a limited number of subjects have received the most attention. Among them I may name the study of double salts, of the rare earths and of complex acids and bases. All this work is of value; some of it is fundamental; but more urgent, probably, is a revision of the older data concerning much simpler bodies. This task is not attractive; it is far from brilliant in character and promises no startling discoveries; but it is none the less essential if we wish to establish the foundations of chemistry more securely. Consider any group of inorganic compounds, as, for example, the anhydrous metallic halides, and we soon find that our knowledge of them is full of gaps, and that the descriptions of many presumably well-known substances are wretchedly incomplete and defective. To remedy this condition of affairs is no small matter; there are errors to eliminate and careless work to be done over; but with modern resources a great improvement is possible. Now, thanks to physical chemistry, we can determine molecular weights, either by cryoscopic or ebullioscopic methods; and in the periodic law we have a basis for scientific classification. With these aids to research the new data should assume a theoretical value which formerly was lacking. For instance, the structural side of inorganic chemistry has been wofully defective; but now, knowing the molecular weights of substances, problems of structure may be attacked to advantage. The conception of valency can thus be tested to the uttermost degree.

Underlying all work upon compounds, however, is the study of the elements themselves. We may speculate as to their ultimate nature, or we may condemn speculation as useless; but we must agree that accurate knowledge of their relations and properties is most desirable, and especially so with respect to physico-chemical researches. In order to correlate the properties of compounds with those of their components, we must first determine the latter, and our present knowledge in this direction is exceedingly incomplete. Not one element is thoroughly known on the physical side, and some, indeed, have not as yet been definitely isolated. What we require is the exact measurement of all the physical properties of all the chemical elements at all available temperatures; from such data laws are sure to follow. Here again the periodic law can guide us; for in its curves the measured constants are easiest compared. In this scheme, evidently, the accurate determination of atomic weights is an important feature, for with them all else is coordinated. We also need to know, more completely than we do at present, the molecular weights of the free elements, because the reactions which we really observe are between molecules and not between atoms. Thus, when monatomic mercury unites with octatomic sulphur, the phenomena which occur involve the breaking down of the sulphur molecule. If, instead of mercury, we have diatomic oxygen or tetratomic arsenic, the reaction with sulphur becomes still more complex, for in each case, before combination, two molecules must be dissociated. The dissociation, of course, implies a loss of energy, of unknown amount; and in thermochemical discussions this undetermined factor is the chief obstacle to progress. If we could study reactions between monatomic molecules alone, we should have ideally the

simplest conditions for thermochemical measurement. But such reactions might be difficult to identify, if indeed, they are possible at all. These considerations are obvious enough, but, unfortunately, they are sometimes overlooked.

Of the second great problem of chemistry, the nature of chemical combination, I need say little more. Some of the subordinate questions which grow out of it have been already mentioned, and each of them is a center of activity in the chemical research of the day. The entire field, however, is not covered, and here and there we can see evidences of neglect. First, we need to know under what conditions chemical change is possible. Then, if we would truly understand what chemical attraction means, we must study much more fully than hitherto its relations to other forces. How do heat, or light, or electricity inaugurate a reaction, and how are they produced by it? Questions of equilibrium are important, but they are subordinate to these. Furthermore, is chemical union of one kind only, or do we confuse different phenomena under the single name? Some authors write of atomic and molecular combinations as if they were distinct; are they really so, or is the separation nothing more than a confession of ignorance? For example, what is water of crystallization? Here is one of the commonest phenomena of chemistry entirely unexplained.

Up to this point I have considered the needs of chemistry from the theoretical side alone, as if we had only a matter of pure science to deal with. But the question has other aspects, of equal importance to us, and these now claim our attention. In order to enlarge the possibilities of research, what more do we need in the way of opportunities and resources?

To the sporadic, the piecemeal, the almost accidental character of scientific investigation I have already referred. Rarely do we find a man who can take up a large problem in a large way, with all its ramifications and details; even the most favored investigator must confine his personal work within narrow bounds, and do the best he can in his own corner. The greater part of chemical discovery has been the result of individual effort—the work of men who labored independently of one another, with rare cooperation, and often under conditions of the least favorable kind. By an army of volunteers, undisciplined and unofficered, the victories of science have been won. The time is now ripe for something better—how to organize research is the problem to be solved.

I do not mean to imply, by this suggestion, that any existing agency for research should be destroyed, or even supplanted; for such a proposition would be foolish in the extreme. Individual initiative, personal enthusiasm, are too precious to be lost; they have their part to play in the development of science; and the smallest fact, discovered by the humblest worker, will always be welcome. I do believe, however, that present conditions may be improved; that the efficiency of the individual can be increased; and to this end I urge upon your consideration the possibility of cooperation between those investigators who happen to be laboring in the same field. Ten men, pulling together, can do more than twenty who are apart. Duplication of effort, the useless repetition of work, can at least be avoided.

On several former occasions I have advocated, as the most urgent need of science, the regular endowment of research. By this I do not mean the payment of salaries to men working at random, who shall each choose his own small problem and attack it in his own way. Such a procedure would increase facilities, no doubt, but it might prove to be wasteful in the end. I look rather to the establishment of institutions,

wherein bodies of trained men should take up, systematically and thoroughly, the problems which are too large for individuals to handle. Suppose that some of the wealth which chemistry has created should return to it in the form of a well-built, well-equipped, and well-endowed laboratory, devoted to research alone—what might we not expect from such a foundation! Libraries, museums, schools and universities receive endowments by the score; observatories are equipped for astronomical research; why should not chemistry come in for her share of the benefactions? Are our achievements so great that we seem to need no aid? In this hint there is a modicum of truth; the users of chemistry, the great industrial leaders, see the wonderful resources of our science, and do not realize that she can require more. That the giver of help should herself demand assistance is a hard thing to explain.

This, then, is our greatest need; the endowment of laboratories for systematic research, wherein chemistry and physics shall find joint provision. I say 'systematic research,' in order to distinguish it from the uncorrelated work of separate individuals. In physics, or for physics primarily, a beginning has already been made; the Reichsanstalt, at Berlin, the new physical laboratory in London, and the Bureau of Standards, at Washington, can cover a part of the ground. But it is only a part; for in each case, and in other like institutions, the researches are undertaken mainly in response to industrial demands; to furnish methods and standards rather than to develop principles and laws. The advancement of science as science is quite another affair. Neither does the Davy-Faraday Laboratory in London exactly meet our requirements. It is organized to help individuals, by giving facilities for work; but it does not provide for the systematic investigation of large problems, through the combined efforts of a body of chemists operating under a common plan. These institutions are all steps in the evolution of the research laboratory; but the development, as yet, is incomplete. Laboratories for instruction have been lavishly provided, but in them research is subordinate to teaching. The thesis of the student may represent good work; the leisure of the instructor may be fruitful also; but organized research is a different thing, and must have its own independent resources.

Either at public expense or by private enterprise, laboratories for research should be established in all of the larger civilized countries. By conference between them their work could be so adjusted as to avoid repetition, each one reinforcing the others. Their primary function should be to perform the drudgery of science; to undertake the tedious, laborious, elaborate investigations from which the solitary worker shrinks, but which are nevertheless essential to the healthy development of chemistry. Brilliant discoveries might be made in them, but incidentally, and not as their main purpose. Such discoveries would surely follow if the fundamental work was well done; but the latter should come first as being the most essential. Whether we serve pure science or applied science, we all feel the need of data which are as yet undetermined, and whose ascertainment we cannot undertake ourselves. How often are we baffled in our own researches for want of just such material! In the verification of methods and the determination of constants, the research laboratory would have plenty to do, even were nothing more attempted.

By the creation of laboratories such as I have suggested, the independent scholar might be aided in many ways. The antecedent data, without which his researches are crippled, could often be furnished, thus

opening pathways where obstacles now exist. Furthermore, the desirable cooperation between investigators would become a much simpler matter to arrange than it is now. Every laboratory for research would become a nucleus around which individual enterprises might cluster, each giving and receiving help. A great work, wisely planned, always attracts colaborers; its mere suggestiveness is enough to provoke widespread intellectual activity. Here there is no monopoly, no limit to competition, no harmful rivalry; every research is the seed of other researches, and every advance made by one scholar implies the advance of all. In the realm of thought we gain by giving; and the more lavish our offerings, the richer we become.

We glory in the achievements of chemistry, and we find merit also in its imperfections, for they give us something more to do. Never can the work be finished, never can all its possibilities be known. Hitherto the science has grown slowly and irregularly, testing its strength from step to step, and securing a sure foothold in the world. Now comes the time for better things; for system, for organization, for transforming the art of investigation itself into something like a science. The endowment of research is near at hand, and the results of it will exceed our most sanguine anticipations.

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GRADED CONDENSATION IN BENZINE VAPOR, AS EVIDENCED BY THE DISTORTED CORONAS AND MARKED AXIAL COLOR EFFECTS ATTENDING CLOUDY CONDENSATION.

1. It would be difficult to read the admirable work on the relation of rain and atmospheric electricity which has issued from the Cavendish Laboratory, without being convinced of the strength of the arguments put forth. That in a repetition of these researches, in particular of the experiments of C. T. R. Wilson* on the comparative efficiency as condensation nuclei of positively and negatively charged ions, one would but reproduce his results admits of no doubt.

In so important a question, however, it is none the less desirable to reach identical conclusions from entirely different methods of approach. It has been part of my purpose to be driven to like inferences; in other words, to reach a point in my work where I should have to abandon the nucleus as an agency which for purely mechanical or thermodynamic reasons facilitates condensation, and be compelled to recognize the special activity due to its charge.

I had hoped to accomplish this in the following experiments with benzine when contrasted with the corresponding behavior of water; but the results, contrary to my expectation, are so curious and pronounced an accentuation of the nuclear theory that it seems worth while to specially describe them.

2. The work originated in the following point of view: if the action promoting condensation is in any degree of a chemical nature (such suppositions have been made; the production of hydrogen superoxide, for instance, has been suggested), then there should be a marked difference in the efficacy of the same nucleus when the saturated water vapor is replaced by the vapor of some electrolytically neutral liquid, like a hydrocarbon. I accordingly made a series of experiments with benzine, endeavoring at first to utilize benzine jet and color tube in the usual way. In this I failed for reasons without much relevant interest here. I then adopted the method of adiabatic cooling, partially exhausting a spherical receiver (Coulier, Kiessling) about 23 cm. in diameter, illuminated by

*C. T. R. Wilson, *Phil. Trans.*, London, Vol. CXCIII., pp. 289–308, 1899.

white light diverging from an external point. In this way not only were copious fogs obtained, but the coronas* produced were additionally available as evidence.

In the benzine jet, particles are probably cooled too suddenly, and at once attain a size incompatible with axial color effects. Using the exhaustion method, however, these axial colors appearing in benzine are not only of pronounced depth, but they run into higher orders than in the case of moist air subjected to like exhaustions. Sequences passing through blue, green, yellow, brown, purple, etc., green, brown, etc., may be seen in the axis of a column only 23 cm. long. The reason, no doubt, is the lower latent heat of benzine, insuring the formation of drops not less uniform, but of a size, cæt. par., regularly larger than for water vapor. The fact that axial colors are producible both with water and with a pronounced insulator like benzine, is a result of fundamental importance in its bearing on any theory adduced to account for the axial absorption in question.

3. The exhaustion experiments were thus at once successful. Cloudy condensation was as densely produced in benzine vapor as in water vapor, with phosphorus, flame and other nuclei. Care was taken to insure dryness of vessel by test experiments both before the benzine was introduced and after it had been quite removed by evaporation. The exhaustion of about one sixth, say 13 cm., seemed best adapted to bring out the following phenomena. When the receiver was left standing overnight no marked condensation occurred in the absence of nucleation, or else the condensation was rain, like a fine mist, falling about 2 or 3 cm. per second.

The introductory experiments were made with light nearly in parallel, the sun's image being used as a coronal center. The even dense tawny benzine fog after the first nucleation was expected to develop on subsequent exhaustions (each followed by an influx of filtered air) into the magnificent coronas which characterize this experiment in the case of water vapor. On the contrary, however, the fogs were more fleeting, showed a more rapid descent than aqueous fogs, and the color fields obtained were not ring-shaped as expected, but *sharply stratified horizontally,* roughly speaking, in alternations of green and red.

Moreover, if the exhaustions were made successive without influx of air between each, the colors rose in strata from below, as they fell in strata when left to themselves. On mounting, the strata grew successively wider and thinner till they vanished from sight, brown, yellow-white being the last colors observed. Uniform color fields (strata of limiting width) were eventually producible in this way. Yellow, brown, crimson, arose from a whitish blue base, then descended again on completed exhaustion, reminding one of the extension of an accordion. The speed of apparent viscous subsidence of the top bands has no direct meaning, since fall (or rise) is here complicated by evaporation.

On entrance of air, vortices were evidenced by ring-shaped threads of color so that mixture was at first inevitable. One must wait till this ceases before again exhausting. Convection currents due to local reheating of the adiabatically cooled gas by the walls of the receiver, were equally apparent, stringy colors rising on the out-

* For some time I have been making experiments with the coronas of cloudy condensation on a large scale, with the purpose of comparing the diffraction colors so produced with the axial colors of the steam jet. The latter are almost complementary to the colors of the central patches of the corresponding coronas, betraying a difference of origin in the two cases of great theoretical interest. One is tempted to infer that the light axially absorbed illuminates the colored inner circle of the corona, but the proof of such an assertion is a long stride.

side and descending into the middle of the receiver. It is the phenomenon which interferes with the usefulness of narrow tubular apparatus.

4. As this subsidence of color bands in benzine vapor is an observation of importance, I resolved to repeat the work under more normal conditions. Accordingly I used as my source of light the bright area of the mantle of a Welsbach burner, seen through a small hole in the metallic screen by an eye, looking centrally through the receiver containing saturated benzine vapor and nucleated air. Punk nuclei replaced the phosphorus nuclei. On exhaustion (without nucleation) after standing overnight, the coronas were white centered fringed with brown, about as large as ordinary lycopodium coronas seen under like conditions. These large drops are a proof of the relative absence of nuclei initially.

After nucleation the first dense fogs were vaguely annular during the first five successive exhaustions, filtered air being supplied between each. The next five exhaustions produced more nearly, finally very fully stratified colors, in spite of the point source of light. Shaking the receiver violently at any time, so as to scatter the liquid benzine within, always reproduced a nearly perfect corona, which on standing became distorted again, in color at least. I now made special experiments, shaking the receiver before each observation, bringing out successive coronal effects* never as perfect as with water, however, always showing the tendency to stratification. The characteristic coronas succeeded each other so rapidly that it would be difficult to make them out. Nuclei, however, were still present after over two hours, the eventually white centered coronas showing a continued shrinkage to smaller diameters in accordance with the diminishing number of nuclei present. Twenty exhaustions did not remove them.

Here, as above, therefore, the fleeting character of the coronas, their tendency to depart from the normal annular character into stratification, the speed of descent of the color bands, their rise upward on exhaustion like a fog from a lake, are the special characteristics of the colored cloudy condensation occurring in benzine. To these are to be added the striking axial colors mentioned above.

5. To explain the above phenomena in their variation from the normal aqueous corona, it is first necessary to account for the more rapid subsidence of nuclei. I am not aware of appreciable differences of viscosity in the two vapors; but benzine has the smaller latent heat of evaporation by over seven times. Hence under identical conditions of nucleation and for like exhaustions or like adiabatic cooling of a given mass of saturated air, the drops would be larger, the colors more advanced in benzine than in water; and since the square of radius is in question, this would point to subsidence of the loaded nuclei in benzine nearly four times more rapid. It would also account for more rapid evaporation or more fleeting colors, which is the case.

Again, if the loaded nuclei be regarded as mechanical particles, the largest will eventually be found in the lower strata, the smallest in the upper strata, as in a case of ordinary subsidence of suspended matter in water. It is well known, moreover, that smaller droplets wane, larger droplets grow. Hence on increasing exhaustion condensation takes place first at the bottom and last at the top, since the smallest nuclei correspond to greatest vapor pressure or difficulty in condensation, and since the largest nuclei have been loaded with condensed liquid first, have parted with it last, have had greater time

* These will be described for water vapor in a subsequent paper.

in falling and have therefore sunk deepest before losing their liquid load. The strata mount upward as fresh exhaustion proceeds. The last colors to appear are the browns and yellows of the first order, also seen in the steam tube for vanishing condensations. The whole phenomenon is thus the result of strata of invisible nuclei, *graded in virtue of the loading mechanism,* and partakes throughout of a mechanical character to the extent that the nuclei are *not even a uniform product.* The forced distribution is sufficiently powerful to entirely mask the elementary optical phenomenon.*

On shaking the liquid benzine in the receiver uniform distribution is again promoted, with the result that annular coronas reappear. It is particularly to be noticed that subsidence is due to loaded nuclei. The free nucleus does not appreciably descend. Even with water vapor, loading does not produce stratification. Water fogs when exceptionally dense may sometimes be seen to rise, but the diffraction pattern is always annular and usually without color distortion.

* Since writing the above I have made similar experiments with benzol, reaching the additional result that nuclei are produced by the liquid itself, *spontaneously,* in the dark. They ascend against gravity in horizontal strata, at the rate of 2 or 3 cm. per sec. in the lower hemisphere. They may be completely precipitated by partial exhaustion, leaving the air in the vessel free from nuclei (but the above flask will be refilled to saturation in 10 or 20 minutes). The experiment may be repeated any number of times. The sharp demarcation of the pure air above from the rising surface of nuclei is beautifully evidenced by the coronas, which are annularly perfect for axial beams below the surface, asymptotically *bowl-shaped* at the surface, and absent for axial beams above the surface. Shaking produces the coronas from pure air instantly, but these are usually smaller. In so far as the spontaneous coronas have fixed diameters for fixed exhaustions (supersaturation), the number of nuclei eventually reaches a maximum or saturation. Among many interesting problems growing out of the present observations, the corresponding behavior of water is most important.

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DATA ON SONG IN BIRDS: THE ACQUISITION OF NEW SONGS.

THE purpose of this paper is to set forth the evidence that has come under the writer's personal observation regarding the propensity of birds to acquire new methods of expression in song.

This faculty may be properly divided into three categories: First, the disposition of wild birds to interpolate new phrasing into what may be called their normal song, or *to acquire new songs.* Second, education of expression, by direct teaching from man to birds in confinement. Third, the propensity of caged birds to imitate, voluntarily, sounds that attract their attention.

The evidence under the first division of this thesis is absolute and also well known. However, a few special cases may serve to emphasize the matter.

Every trained field ornithologist discriminates individuality in song, and some have been so fortunate as to have noted wide and radical departures from what I have distinguished as the normal song. The slight variation from the normal is of too common occurrence to be dwelt on here. Suffice to say that as set forth in a previous paper in this journal,* most observers recognize degrees of excellence in the songs of wild birds of the same kind.

Again, a few observers have heard wild birds imitate or produce not only the songs of other birds, but also the barking of dogs, human speech and mechanically produced sounds such as the creaking of a wheel, the filing of a saw and the like. The facility

* See SCIENCE, October 4, 1901, p. 522.

of the mocking-bird in this particular is traditional. A few other instances seem worthy of record.

A catbird (*G. carolinensis*) that nested in the immediate vicinity of my house in the season of 1900 reproduced the call of the whip-poor-will (*A. vociferus*) so perfectly that it was difficult to induce members of my family and visitors who heard the reproduction to credit the fact that it was not the whip-poor-will singing. A friend who knew nothing about the catbird as an agent in the performance and who had not had her attention called to the matter in any way told me that she had heard a whip-poor-will singing near my house repeatedly in *the day time*, and wished to know if this was the ordinary habit of the bird. In a residence of some twenty years in this locality I have never heard whip-poor-wills nearer to the point in question than three miles.

The following case of a wild rose-breasted grosbeak (*Z. ludoviciana*) *talking* is well attested. I quote from Emily B. Pellet, Worcester, Mass., in *Bird-Lore*, Vol. III., No. 5, p. 174, October, 1901, as follows: "Early last summer, while standing on my back steps, I heard a cheerful voice say, 'You're a pretty bird. Where are you?' I supposed it to be the voice of a parrot, but wondered how any parrot could talk loud enough to be heard at that distance, for the houses on the street back of us are quite a way off.

"Almost before I had done laughing, the voice came again, clear, musical and strong—'You're a pretty bird. Where are you?'

"For several days I endured the suspense of waiting for time to investigate. Then I chased him up. There he was in the top of a walnut tree, his gorgeous attire telling me immediately that he was a rose-breasted grosbeak.

"At the end of a week he varied his compliment to 'Pretty, pretty bird, where are you? Where are you?' With a kind of impatient jerk on the last you.

"He and his mate stayed near us all last summer, and though I heard him talk a hundred times, yet he always brought a feeling of gladness and a laugh.

"Our friend has come back again this spring. About May 1 I heard the same endearing compliment as before.

"Several of my friends whom I have told about him have asked, 'Does he say the words plainly? Do you mean that he really talks?' My reply is, 'He says them just as plainly as a bird ever says anything, so plainly, that even now I laugh whenever I hear him.'"

Space will not allow the further elaboration of this part of the subject.

The second division, that of education of birds in song and speech by man, is also well known. The bullfinch's (*Pyrrhula europæa*) ability to learn to whistle airs with great accuracy and precision, as well as the peculiar quality and charm of its voice, has arrested the attention of all observers and has been cultivated for more than a century. Few of us, however, realize that only *wild birds* hand-reared from a very early age are educated in this accomplishment, and it is worthy of special notice that wild bullfinches have little or no song, and may be compared with the European sparrow (*P. domesticus*) as a songster. Starlings (*Sturnus vulgaris*) are well known as birds susceptible not only of learning to whistle simple melodies, but as rivals of parrots in reproducing with great distinctness short sentences. Parrots are proverbial as talkers, singers and whistlers. Canary birds have frequently been recorded as learning to whistle simple tunes, and there are a number of well-attested accounts of their reproducing with precision short sentences. Jays, crows and magpies also talk and whistle with

great facility. The voices of jays in reproducing speech are particularly melodious and lack the peculiar phonographic timbre characteristic of most parrots and of starlings.

Mention must be made here of the minos (genus *Mainatus*) of India as on the whole the most receptive among birds in learning to talk, sing and imitate all sounds of a mechanical kind. All these results have been achieved by education, that is, direct teaching with intent on the part of the human instructor.

The third part of this discussion, that which deals with the propensity of caged birds to imitate or reproduce, voluntarily, sounds that attract their attention, needs a few words of explanation.

No direct effort or intention on the part of a human agent is a factor in this category. All but one instance that I shall adduce of this kind of ability have occurred in an experience covering some six or seven years with birds obtained in ways, and kept under conditions, that require brief consideration. These birds are all hand-reared wild species; birds taken from the nest when very young and raised by hand. As soon as such birds were able to feed and care for themselves they were liberated in large rooms having as near freedom as confinement would allow. No instruction was given to them. In a word, it was an effort to observe *what birds would do if left to themselves and supplied with food and water.* No effort was made to keep these birds from hearing the song of wild birds out of doors. The species dealt with in this way are comprised in the following list:

12 bluebirds (*Sialia sialis*).

14 robins (*Merula migratoria*).

6 wood thrushes (*Hylocichla mustelina*).

7 catbirds (*Galeoscoptes carolinensis*).

2 thrashers (*Harporhynchus rufus*).

2 yellow-breasted chats (*Icteria virens*).

2 rose-breasted grosbeaks (*Zamelodia ludoviciana*).

1 cardinal (*Cardinalis cardinalis*).

6 Baltimore orioles (*Icterus galbula*).

7 orchard orioles (*Icterus spurius*).

1 bobolink (*Dolichonyx oryzivorus*).

2 cowbirds (*Molothrus ater*).

4 crow-blackbirds (*Quiscalus quiscula*).

5 red-winged blackbirds (*Agelaius phœniceus*).

1 meadow-lark (*Sturnella magna*).

6 blue jays (*Cyanocitta cristata*).

It will be sufficient for us to consider only the very marked acquirement shown by individuals among these birds, none of whose songs are quite normal. A number of the robins have peculiar songs that in no way resemble wild robins' songs. I should call them *invented* songs, for lack of a better name.

The wood thrushes' song varies much from the normal, but can hardly be regarded as invented or original.

Catbirds did much mimicry of the songs of other birds.

A yellow-breasted chat is worthy of particular mention. This was a bird taken with another from a nest in May. In September of the same year I was busy in correcting proof for a forthcoming book of some size, so that for at least three months a part of each day was devoted to this work. The manuscript and proof were delivered by a postman. There were three deliveries each day. Ordinarily the postman dropped the mail into a slot in the door, but when he had a package of proof this was not feasible and he sounded a call or postman's whistle for some one to come to relieve him. One afternoon in September, about the time I was expecting proof the whistle sounded and I went to the door. No one was there. My first impression was that some boy in the neighborhood was up to mischief. The experi-

ence occurred four or five times in the next day or two and I began to regard it as mysterious, never thinking of the birds in such a connection. Some four days later while watching the birds—I was in the room with them—a chat came and alighted on my shoulder and shrill in my ear sounded the exact reproduction of the postman's call. The very direction and distance from which the call came and its exact tone were reproduced. I heard it many times afterward, friends and other members of the family became familiar with the call, and even after I was aware of it, when I was expectant, I have heard the postman, gone to the door and finding no one, knew how realistic was the reproduction of the postman's call by a yellow-breasted chat.

One of a brood of red-winged blackbirds (*A. phœniceus*), a male, crows constantly for all but two months in the year. The crow is an imitation of the crow of the common bantam rooster. Distance and direction are clearly indicated. The sound always appears to come from the rear of the house, at some little distance, and is a very clever imitation of the crow of a bantam rooster. This is the only song this bird has.

A blue jay (*C. cristata*) reproduces the song of the cardinal (*C. cardinalis*) so perfectly as to deceive any one. It is copied from a cardinal in the room, and distance and direction are not indicated.

A European jay (*Garrulus glandarius*) has learned from a cockatoo to say 'How do you do,' 'How do, pretty polly,' 'Pretty polly' and some whistles and calls.

"Last summer on a Wisconsin farm there was a duck hatched out with thirteen turkeys by a hen as a foster-mother. This duck followed the turkeys around and wavered a very long time before it went into the water, and it still imitates the *turkey's note* with its *duck voice*. It sleeps under the turkeys' roost at night now, although it is quite an old duck, and scorns the company of the other ducks on the plantation. This interesting family is on the farm of Mr. Clinton D. Stewart, whose post-office address is Dousman, Wisconsin. Mrs. Merrick first called my attention to the duck's turkey call; but I was not entirely satisfied until I heard it myself." (Extract from letter of Edwin T. Merrick, 836 Gravier street, New Orleans, La., October 19, 1901, to W. E. D. Scott.)

This call of the turkey given by a duck is of special interest as præcocial birds appear to have much less receptivity than altricial birds. The reason seems obvious.

In concluding a word is necessary as to the probable reason why birds in confinement diverge from the normal in the habits of song. Presuming that wild birds are pretty constantly employed in obtaining a food supply, it would seem that they *do not have much leisure*. On the contrary, birds in captivity with all their physical wants carefully looked after, *have leisure* and employ it in giving their attention to occurrences about them, particularly such as are accompanied by any noise.

Of this factor of leisure among animals in confinement little is known, and a broad field is presented for those investigators who have opportunities in zoological gardens or, better still, in special laboratories equipped for this and kindred studies.

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MUSEUM STUDY BY CHICAGO PUBLIC SCHOOLS.

THE Field Columbian Museum is often visited by classes from the Chicago public schools for purposes of instruction obtained by studying the illustrations there afforded of different subjects taught in the schools. The character and value of such

work vary of course with the age and standing of the pupils, and doubtless as well with the individuality of the teacher.

The teachers with whom I have talked are unanimous in saying that the pupils enjoy study at the Museum, not having to be urged to it as to book study, partly, of course, because of the change it affords from the routine of school work, but largely because the objects of study are so tangible and interesting of themselves. Many of the scholars spend considerable time in voluntary study at the Museum outside of school hours. The teachers also say, however, that as might be expected, no immediate results are realized from such work unless the pupils know that some report of their studies will be called for. Such report may be made orally or as a written report on some department of study, or on topics previously assigned. I have sometimes examined such written reports and have found their perusal of considerable interest and value. They furnish as accurate a test as could be devised, probably, of the amount and kind of instruction which pupils are likely to obtain from study of objects in a museum and as well also of that likely to be obtained by those 'children of a larger growth' who visit the Museum with a less definite desire for instruction, but who imbibe it nevertheless. The particular lot of reports now lying on my desk is one of about twenty made by pupils in a class in physiography in the first year in high school, ages say 13 to 15 years. The reports or essays as they might also be called, are descriptive of a visit to the geological department of the Museum for the purpose of finding and noting illustrations of the text-book study of physiography. The pupils were expected to make drawings as well as notes of the objects which they deemed important and such drawings accompany the essays. Some suggestions had previously been given the pupils by the teacher as to topics for study, such as the description of fossils from each of the great geological periods; the study of crystals, meteorites, some special relief maps, etc.

Some points noted in the perusal of the essays may be worthy of comment. The ideas gained by the pupils from the study of the collection of fossils were isolated and fragmentary. Single forms were drawn and described with considerable accuracy, but there seemed to be little conception gained of the march and development of life as a whole, although the collection is sufficiently large and complete to make this manifest. Still, several noted the introduction of fishes in the Devonian age and the excess of vegetation in the Carboniferous. None of the pupils mentioned the animals of larger size, although many skeletons and restorations of these are exhibited. It is curious that while the average visitor of maturer age devotes his attention almost exclusively to these, I have never noticed young people take much interest in them. They take more interest in small objects, such as shells, impressions of ferns, etc. The color of the fossils or matrix was often noted and throughout the essays observation of color is the one thing prominent. The remarks on crystals contained few observations calculated to encourage the modern crystallographer. Almost anything in the mineral collection was regarded as a crystal and the observations made were chiefly on differences of color. From a collection of crystals arranged according to the six systems, one scholar drew the sweeping conclusion that 'isometric crystals are green, yellow-green or cream color; those of the tetragonal system generally red, those of the hexagonal system vermilion,' etc. This was a conclusion from scanty data, but the scoffer may be reminded that the whole world did not do

much better in its study of crystals up to the beginning of the seventeenth century, as witness its reasoning that because quartz was found on the high Alps and sometimes contained water that *ergo* it must be ice frozen so hard it could not melt. A few of the pupils, however, distinguished crystal forms quite accurately and drew excellent representations of them. I believe distinctions of form might be easily taught to pupils of this age and even younger if more attention was paid to it. In nearly all lines of scientific study form is far more important than color.

In their study of meteorites nearly all noticed the 'thumb marks' and gave a reasonable explanation for them. They also noticed the composition of meteorites as made up of iron and stone in different amounts. The finer details of structure were entirely overlooked, however. Only one noticed the Widmanstättian figures, describing them as 'scratches,' and the chondritic structure was not noted at all.

The observations drawn from a study of the relief maps excelled all others in accuracy and fullness.

The region of the Grand Cañon of the Colorado, for instance, was correctly described as a valley worn to a profile of equilibrium into which a subsequent cañon had been cut by the rise of the land. This had doubtless been stated in the text-book, but the relief map evidently gave the subject a vividness and reality. So also from a map showing the extent of the continental glacier, the southern limit of the glacier was correctly traced and a permanent impression, doubtless, of an important fact gained. On other relief maps the positions and relations of plateaus, divides and slopes were correctly noted and single geologic features accurately described. One could not read over the portions of the essays devoted to this subject without being convinced that relief maps are most desirable adjuncts for the teaching of geography.

Some glaciated surfaces were noted by all, but few gave a correct explanation for the markings on them although the origin of the markings was stated in an accompanying label. One thought they were due to running water, another to 'undulations in the ground moraine.' I doubt if the young mind is able to conceive fully of the physical effects of a continental glacier.

Graphite was studied by many of the pupils, their interest in it presumably being aroused by their familiarity with it in lead-pencils. The fact that it was black was the principal point noted, although some listed the localities whence it is obtained. From some inconceivable source one lad drew the information that "graphite is used for egg coal, because it contains a great deal of oil, so that it is used where a fire is needed. Coal dust moulded by pressure forms graphite."

The accounts of petroleum and its uses were generally full and accurate and must have been drawn almost entirely from observations on the collection. Such a knowledge of petroleum could not have been gained by reading a dozen books. Asbestos, salt, gypsum, mica and sulphur were among other substances noted, some account being given of the appearance and uses of each. The statements were partly second-hand and partly original, with no evidence of any particular skill in observation. One girl, for instance, stated she could see no difference in appearance between gypsum and asbestos, though the distinction should have been plain. It was evident that the pupils had not as a whole been trained to careful observation, for many obvious distinctions were overlooked.

On the whole the essays showed the need of museum study rather than important results from it. They painfully evinced the fact that copied labels and statements

of text-books furnished the material out of which they were chiefly made. Doubtless many of the labels were copied without a glance at the specimen which it accompanied. There was far too little evidence of individual, independent observation. Let it be noted, however, that the essays which contained the most personal observations were the most accurate. It was in the essays most largely made up of copied labels that such strangely conglomerated statements as those I have quoted were to be found. This inculcated slavery to print is to my mind one great weakness of modern instruction in the elementary schools, so far as any hope of the promotion of science is concerned, and it is in museum study that one of the best remedies for it is to be found. In order that independent study may be encouraged it may be questioned whether the museum label should aim to give very extended information. To be sure, the mere copying or reading of the label serves to some extent to fix the information it contains upon the mind, but the knowledge would take firmer hold if this information could be gained by a study of the specimen. I have often noticed visitors of all ages studying an unlabeled collection with the greatest persistency and interest, and then have seen them finish it in a glance after it was labeled. They seemed to feel that they were relieved of any further responsibility in regard to it as soon as they saw the labels. Hence, Goode's well-known aphorism that 'a museum should consist of a collection of instructive labels illustrated by specimens' has its limitations. Uttered to call attention to the need for system and as a protest against the lumber room, it had a profound value, but modern experience will hardly consider it a final ideal. It is possible to so prepare and arrange collections that they will tell their own story without more labels than are needed to serve as hints or indexes. Such collections or exhibits will promote the spirit of observation, study and inquiry, and the more they do this the more will they contribute to the advancement of science.

OLIVER C. FARRINGTON.
FIELD COLUMBIAN MUSEUM.

THE BOUNDARY LINE BETWEEN TEXAS AND NEW MEXICO.

THE boundary line between Texas and New Mexico along the 103d meridian was the chief theme of a talk before the National Geographic Society on November 15 by Dr. Marcus Baker. This boundary, created in 1850, was surveyed and monumented, in part, in 1859 by John H. Clark, and his survey was confirmed by Congress in 1891. Recent official maps place this boundary two or three miles west of the 103d meridian, where the law declares it to be. The paper read before the Society was a summary of the results of an enquiry undertaken to discover and weigh the reasons for this discrepancy.

The original monuments set by a survey to mark a boundary in accordance with law, become, when confirmed, the boundary, even when followed by more accurate surveys which show the original monuments not to be where they were designed to be. The more accurate survey does not alter the boundary. It merely shows how well or ill the original survey was done. Of this line, 310 miles long, 180 miles were traced out and marked by mounds of earth or stone in 1859; the remaining 130 miles have not been surveyed. Of the 180 miles surveyed and marked, 24 are at the south end marked by 3 mounds and 156 at the north end marked by 23 mounds. The longitude of the south end of the line was determined by chaining eastward from El Paso along the 32d parallel 211 miles, the initial station being

Frontera of the Mexican boundary survey. Obviously this is a very weak longitude determination. It was not checked by astronomical observations originally, nor has it been since. Nor has it been checked in any other way. According to present knowledge the three monuments at the south end are on the 103d meridian and should be so shown on our maps until subsequent and better surveys shall find these monuments and show that they are not on the 103d meridian. As to the 130 miles of unsurveyed line north of the short piece, at the south end of the boundary, this part is obviously coincident with the meridian.

The longitude of the 23 mounds on the northern part of the line depends upon the one at the N.W. corner of Texas. That corner monument was set in August, 1859. Its longitude was obtained by transfer from some point on the 37th parallel, 35 miles to the northward. In 1857 a surveying party under Lieutenant-Colonel Johnston measured westward along the 37th parallel from the west boundary of Missouri 471 miles to the 103d meridian. Clark was the astronomer in Johnston's party and determined by moon culminations the longitude of the monument set by Johnston to mark the intersection of the 103d meridian and 37th parallel. The longitude of the mound at the N.W. corner of Texas, set by Clark in 1859, therefore depends upon the longitude of a point determined by himself, astronomically, two years previously on the 37th parallel. How accurate was Clark's determination? Nobody knows. Various surveys under the direction of the Land Office have been made in this vicinity since Clark's original one, but his monument has not been found. Two monuments have since been established to mark the point which Clark intended to mark and which he supposed he did mark. One of these was set by John J. Major, in 1874, and another by Richard O. Chaney, in 1881. Major searched for Clark's monument, failed to find it and 'reestablished' it, *i. e.*, set a new one. The evidence is conclusive that Major's monument was set more than two miles west of Clark's. Chaney's monument is some four or five miles east of Major's. Chaney did not find either Clark's or Major's. Thus three monuments or mounds have been built to mark the N.W. corner of Texas, one by Clark in 1859, another by Major in 1874, and a third by Chaney in 1881. Clark's alone marks the boundary and that one is lost.

Of the 22 remaining mounds marking the northern part of the boundary two, and only two, are known to still exist. These two are in sight of one another and on opposite banks of the Canadian River. They were found and reported to the General Land Office by the land surveyors Taylor and Fuss in 1883. We have no information as to their longitude other than that furnished by Clark himself, who reported them on the 103d meridian.

In the present state of our knowledge it seems highly desirable that the boundary should appear on our maps on the 103d meridian. At the same time it is even more important that topographic surveys be made along this line and as many as possible of the original Clark monuments identified and accurately placed on the map. This done the whole line should be run out, old monuments restored and new monuments built. If this is done before the discovery of oil, mineral or things coveted, a costly and bitter boundary dispute can be avoided.

Since the above was written I have learned of a recent survey which has materially added to our knowledge of the present state of this boundary. Mr. E. D. Preston, U. S. Deputy Surveyor, retraced the Clark line on the 103d meridian from

the Canadian river northward to the corner, a distance of about 75 miles, in the summer of 1900. This was done by direction of the General Land Office and his MS. report is now on file in that office. Of the 12 monuments set by Clark in 1859 on this part of the line Preston identified 3 certainly and, doubtfully, 4 in all. Clark's line, according to Preston, bears N. 0° 08′ W.

In 1882 W. S. Mabry, county surveyor of Dallam county, the northwesternmost county of Texas, retraced a part of the Clark line and assisted in building a pasture fence for the XIT or Capital Land and Cattle Company. The corner of that pasture was established at the point supposed by Mabry to be Clark's corner. This XIT corner is now locally recognized as the N. W. corner of Texas. According to Preston's survey it is 'within 150 links of the proper position east of the Johnston monument.' It is about $2\frac{1}{4}$ miles east of the lost Major monument of 1874 and is 2 miles 14.05 chains west of the Chaney monument of 1881. Clark's monument, according to Clark, is in longitude 103°. Chaney's monument, according to Chaney, is in longitude 103°. These monuments differ in longitude by more than 2 miles. Which one is the better determination is unknown. Both longitudes are weak—Clark's is a fair determination by a weak method, Chaney's a weak determination by a strong method. A new and strong determination by a strong method is much to be desired.

SCIENTIFIC BOOKS.

Biologia Centrali-Americana, Insecta, Lepidoptera-Rhopalocera. By FREDERICK DUCANE GODMAN, D.C.L., F.R.S., and OSBERT SALVIN, M.A., F.R.S., etc. Vol. I., Text, pp. i–xlvi + 1–487; Vol. II., Text, pp. 1–782; Vol. III., Plates, I.–CXII. and XXIVa. Published by the authors. Royal 4to. 1879–1901.

In the present age it is recognized as one of the functions and duties of wealth to minister at the altar of learning. The upbuilding of great institutions, the object of which is the ascertainment of truth and the diffusion of knowledge, is regarded as one of the high prerogatives of those who have command of material resources. Splendid have been the achievements in recent years of those who have consecrated their wealth to founding or aiding in the endowment of colleges, universities, libraries and museums; but perhaps no enterprise undertaken by wealth is likely in coming years to be regarded as more important and monumental in its character than the great work to which Messrs. Frederick Ducane Godman and Osbert Salvin addressed themselves when they conceived the idea of preparing and giving to the world the encyclopedic work known as the Biologia Centrali-Americana. Of this work it may be said that it constitutes *monumentum aere perennius*.

It is with profound satisfaction that we welcome the appearance in final form of the three volumes devoted to the Rhopalocera of Mexico and the Central American republics. For twenty-two years these volumes have been slowly appearing in parts. The delay is most reasonably explained by the surviving editor and author, Mr. Godman, as due 'to the constant pressure of other work, the ever-increasing amount of material, the gradually failing health and subsequent death of Mr. Salvin, and the great difficulty of dealing with the Hesperiidæ.' The work, however, has not lost, but has rather profited by delay. The exceedingly satisfactory treatment of the Hesperiidæ, which a few years ago would have been impossible, and the supplementary pages and plates cause the student, now that the work is completed, to feel thankful that the editors followed the good maxim, *festina lente*. Had they completed the work before the region had been traversed by the various collectors whom their munificence placed in the field, and had they not been able to profit by the researches in the family of the Hesperiidæ made by Captain E. Y. Watson, the work would not have been the eminently satisfactory work which it now proves to be. There is yet much to be

learned in reference to the lepidopterous fauna of Central America, and the last word has not been spoken even by the learned authors in the three stately volumes before us, but a foundation has been laid so broad and solid and enduring that all who come hereafter will be compelled to build upon it. These three volumes in a peculiar sense reflect the intelligence as well as the generosity of the two lifelong collaborators, Messrs. Godman and Salvin. With the exception of the volume upon the avifauna of the region, written by the same two gentlemen, they most strongly illustrate their learning. Other volumes in the great work reflect the excellence of their editorial supervision, as well as their munificence, but the parts of the 'Biologia' which have issued from their own hands and most strikingly display their scientific accuracy and the vastness of their learning are the volumes dealing with the birds and these three volumes treating of the butterflies.

Eighteen hundred and five species of butterflies are enumerated in the work as occurring within the region, three hundred and sixty of them being described as new to science. Of these species about twelve hundred and fifty are figured in the one hundred and thirteen hand-colored plates drawn by Rippon and by Purkiss. It will be seen from the foregoing statement that the region chosen is far richer in the number of the species of Rhopalocera than the continent of North America north of Mexico or the Palæarctic region, the latter covering Europe and northern Asia. The last published list of the diurnal lepidoptera north of Mexico cites but six hundred and forty-five species, a few of which, however, are doubtful, to which must be added a few others recently described. There are probably not more than seven hundred valid species of butterflies to be found on the entire continent of North America from Florida and the Rio Grande of Texas to the Arctic Ocean. Staudinger & Rebel's Catalogue, which has just appeared, enumerates seven hundred and sixteen species as found in the Palæarctic region, covering the Barbary States, Europe, Asia Minor and temperate Asia north of the Himalayan ranges. Within the comparatively small area of Mexico and Central America more species of butterflies occur than are found in all temperate North America, Europe, North Africa, and temperate Asia put together.

Compared with the fauna of the West Indian Islands so far as known, the latter are exceedingly poor in the number of genera as well as species of butterflies. While strictly correct lists of the species of Rhopalocera found on the various West Indian Islands are not available for purposes of comparison, enough is positively known to make it certain that all of these islands together do not contain more than one third of the number of species which are accredited to the region covered by the 'Biologia.' In fact, it is doubtful whether these islands have more than one fourth as many species as are found in the territory of which we are speaking, provided the Leeward Islands and Trinidad be excluded, as appears to the writer proper, in view of their close contiguity to the South American mainland.

An examination of the exceedingly interesting table given in the introduction to the work, which is devoted to the display of the geographical distribution of the various species, shows that the region in and about Panama is probably the most prolific, Costa Rica and Guatemala following closely. It is here, in the humid tropical forests, that we have the fullest development of the Rhopalocerous fauna of the territory. The table of distribution is summarized as follows:

Nymphalidæ, ...	588	species
Libytheidæ, ...	1	"
Erycinidæ, ...	240	"
Lycaenidæ, ...	234	"
Papilionidæ, ...	186	"
Hesperiidæ, ...	556	"
Making a total of.....	1805	"

Comparing this list with the great list of the 'Rhopalocera Ethiopica,' recently published by Professor Aurivillius, and adding the Hesperiidæ from the Ethiopian subregion, which number about three hundred and seventy-five species, we find that the continent of Africa and the adjacent islands have up

to the present time only yielded us about two thousand species of Rhopalocera. It is evident, therefore, that the Neotropical region, which includes tropical South America as well as Mexico and Central America, is likely to prove to possess, when a final and exhaustive catalogue of the species is made, the richest Rhopalocerous fauna in the world. The family of the Hesperiidæ is far richer in species in this region than anywhere else. More species of these interesting and often puzzling insects occur in Mexico and Central America than are found either in the tropics of the Indo-Malayan region or in the tropics of Africa. The Erycinidæ are also characteristic of the region, and the number of species of this family in the total vastly exceeds the number of species found in all other regions of the globe combined. The Nymphalidæ lead all other families in the number of species, but the number of species, while great, is not equal to the number that is found in the Ethiopian subregion, nor is the number of species as great as that known to occur in the Indo-Malayan subregion.

The general conclusions reached by Mr. Godman as to the distribution of species within the territory are best expressed in his own language. He says: "Our study of the Central American butterflies proves conclusively (1) that the fauna is mainly a northern extension of that of tropical South America, extending on the Pacific side to Mazatlan and on the Atlantic to a little beyond Ciudad Victoria in Tamaulipas, some few species on each coast reaching the southern United States, with, of course, many peculiarly modified forms in the region; (2) that there are a considerable number of Nearctic genera and species coming down the central plateau a certain distance into Mexico, and some even into Guatemala, as *Argynnis, Vanessa, Limenitis, Grapta,* various *Colias,* etc.; (3) that there are no strictly alpine forms, the insects met with above the tree-line being mostly stragglers from below, such species as occur at the highest limits of the forest being very like those of similar Andean localities, these mostly belonging to the genera *Euptychia, Archonias, Catasticta, Pereute, Enantia,* etc.; (4) that the fauna of the Atlantic slope to perhaps as far south as Costa Rica is incomparably richer than that of the Pacific, this being particularly noticeable in the Ithomiina, the Erycinidæ, the genera *Thecla* and *Papilio,* etc.; and (5) that some of the purely tropical genera do not reach north of Nicaragua, Costa Rica or Panama, as *Eutresis, Scada, Cœrois, Callitœra, Hetœra, Oressinoma, Narope, Panacea, Megistanis, Hypna, Zeonia, Ithomeis,* etc."

Within the limits of a brief review such as this it is impossible to take up and consider many of the interesting details in reference to distribution which present themselves to view upon a careful study of the work. The writer commends to the careful attention of all students of entomology the introductory chapter of Volume I., which epitomizes in a masterly manner the results of the years of study which have been devoted by the learned authors to the subject in hand. To the comparatively few who are devoting themselves to a critical study of the Hesperiidæ that portion of the work devoted to this family is of extreme value. It is no exaggeration to say that it is one of the most perfect examples of careful monographic work which has ever appeared in the English language. The amount of painstaking and microscopic research which has been performed in order to attain the results which are given has been prodigious. It is certainly to be hoped that the work will find a place in all the great libraries of the New World, for without access to it the student of entomology in America is certain to find his labors greatly retarded.

W. J. Holland.

Carnegie Museum, Pittsburgh.

A Laboratory Course in Bacteriology, for the use of Medical, Agricultural and Industrial Students. By Frederic P. Gorham, A.M. Philadelphia and London, W. B. Saunders & Co. 1901. 8vo. Pp. 192.

In this unpretentious laboratory guide the author has succeeded in combining technical accuracy with sound pedagogy in a manner which will commend the book to teaching bacteriologists. The directions for even the commonest processes have very obviously stood the

test of actual use with classes before being crystallized into their present form. The particular merit of the book lies in the fact that the author has carefully described small points of technique which too many others writers have left for the student to learn for himself through experience more or less bitter.

The contents of the book are as follows: Chapter I., Microscopical Examination of Bacteria, with a description of the ordinary processes of staining; II. and III., Morphology and Reproduction, with methods of straining flagella and capsules; IV., Classification of Bacteria—a synopsis of Migula's genera; V. and VI., Sterilization, and Preparation of Culture media; VII., Cultures of Bacteria—a description of the ordinary culture methods, with full tables of descriptive terms; VIII., Determination of Species, contains a list of diagnostic characters, a standard chart for full description of a species, a key for tracing the more common forms, and a synopsis of Chester's scheme of classification by groups; IX., Bacterial Analysis of Water, Milk, Air and Soil; X., Pathogenic Bacteria—directions for the study of eleven typical pathogenic organisms. The appendix contains an account of Wilson and Randolph's method of measurement by photography, a description of the common contaminating moulds and yeasts, and a very useful list of synonyms.

Not a few points and methods are described which have hitherto appeared only in monographs; some are here published for the first time. The text is fully illustrated, and many of the cuts are new.

On account of its thoroughly modern and in many respects original treatment of the ordinary technique of bacteriology this book will prove useful not only to the bacteriologist, but to the botanist who employs bacteriological methods in pathological or systematic work.

HAVEN METCALF.

THE UNIVERSITY OF NEBRASKA.

SOCIETIES AND ACADEMIES.

THE GEOLOGICAL SOCIETY OF WASHINGTON.

THE 122d meeting of the Society was held on Jan. 8. The first paper was by Mr. Charles D. Walcott on 'The Outlook of the Geologist in America.' This was the substance of the presidential address, before the Geological Society of America, at Rochester.

Mr. M. R. Campbell then presented a paper on 'Recent Geological Work in Pennsylvania.' The author summarized briefly the character and scope of the mapping of the Pennsylvania coal fields which is now being carried on by the United States Geological Survey in coöperation with the State. Up to the present time seven quadrangles, embracing an area of 1,600 square miles in the bituminous coal fields, have been geologically surveyed.

It is generally admitted that the weakest point of the Second Geological Survey of Pennsylvania was its lack of adequate base maps on which to portray the geological data gathered in the field. It was impossible to locate geological boundaries correctly upon the crude county maps, which were the only ones available. With the aid of the recent detailed topographic maps, it is believed that the geological boundaries have been determined within an error of a few feet. The importance of such close mapping is self-evident from the fact that land underlain by the Pittsburg coal is valued at from $300 to $1,100 per acre. The investigations have also brought out many details of structure not previously known, which are of the utmost importance to mine and oil and gas well operators. In closing Mr. Campbell expressed a high appreciation of the labors of the geologists who had preceded him in this field, and stated that their results can only be superseded by the most careful detailed work and by the use of a topographic base map producing a high degree of accuracy.

ALFRED H. BROOKS,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 347th meeting was held on Saturday evening, January 11.

F. A. Lucas exhibited a malformed tooth of Mastodon, of an irregular shape, and with about twice the normal number of cusps, the extra cusps having been mostly added on one side of the tooth.

M. B. Waite presented 'A Problem in Plant

Pathology and Physiology,' stating that last fall he had been called upon to examine a large pear orchard belonging to Mr. A. S. Newson of Algoa, Texas, that was said to be suffering from the effects of blight. On examination it was found, in addition, to be suffering from leaf blight, from lack of cross fertilization and from unfavorable environment, having been planted on prairie soil without any proper natural drainage. Steps had been taken to combat the pear blight, but the result was very doubtful, as the disease could be readily brought in from surrounding orchards. The leaf blight could be remedied by spraying and the cross fertilization supplied by planting other varieties of pear, but it remained to be seen whether or not the locality was too far south for the successful cultivation of pears. These trees, like the peach, needed the rest gained by lying dormant during cold weather.

Wilfred H. Osgood spoke of 'The Supposed Occurrence of Caribou on the Queen Charlotte Islands,' saying that a new species, *Rangifer dawsoni*, had been described on the strength of a single imperfect skull, said to have been brought from Graham Island. Mr. Osgood reviewed the evidence relating to this skull and read extracts from a number of letters concerning it, concluding that in all probability caribou had never been seen in that locality.

Jacob Kotinsky read a paper on 'Present Opinion concerning the Home of the San José Scale,' briefly reviewing the history of the pest from the time of its appearance in California and the attempts to find its original habitat. It was supposed quite recently that Japan was the native place of the scale, but investigation showed that it did not occur in elevated portions of Japan, nor on native trees, while Mr. Marlatt had subsequently located it in China, south of the Great Wall.

F. A. LUCAS.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 31st annual meeting was held Dec. 21, 1901, President Walcott in the chair.

The report of the secretaries was presented by Mr. J. F. Hayford. During the year the principal event has been the incorporation of the Society; 16 meetings have been held for the presentation of papers; Vol. XIII. of the *Bulletin* has been completed and distributed, and 78 pages of Vol. XIV. At present the *Bulletins* are sent regularly as issued to about 300 societies, libraries, etc. A tabulation of the membership for about 20 years, during which time several other scientific societies have been formed at Washington, showed that the loss in membership due to these had now ceased and the Society has reached a steady regime. The present membership is 107. The treasurer's report presented by Mr. B. R. Green showed a healthy financial condition.

Mr. Richard Rathbun, Assistant Secretary of the Smithsonian Institution, was elected President for 1902, and the other officers were reelected.

The 544th meeting was held Jan. 4, 1902.

Mr. D. B. Wainwright, of the Coast and Geodetic Survey, described the experiments made in October last between Nantucket Light ship and the shore, a distance of 48 miles, by the aid of the Marconi apparatus in regular use there, to determine 'Longitude by Wireless Telegraphy.' It was found possible to secure chronograph records of the chronometer beats and the signals from the ship, and then to eliminate the lag of the instruments by causing the chronometer-break to excite the coherer and obtain new chronograph records. Time observations were made and the data were obtained for what is probably the first determination of longitude by wireless telegraph. In the discussion that followed, participated in by several geodesists, the opinion was expressed that even for the short distances through which the new method could now be used, the precision of observation was greater than that of any other method except the telegraphic; its special value would probably be found in work among islands and in unsettled countries like Alaska.

Professor Updegraff then discussed the 'Stability of Astronomical Piers.' The first astronomical instrument was only a pier, the Gromon; and by its aid the ancients determined a surprisingly large number of constants. A pier should be built on soil rather than on rock; brick was now in favor rather

than stone: at the Cape of Good Hope the piers of the meridian circle were iron cylinders filled with water. At the Naval Observatory the marble piers of the six-inch meridian circle had shown a change in azimuth of 0".3 for 10° Fahr., and had recently been replaced by brick.

CHARLES K. WEAD,
Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF BIOLOGY.

A REGULAR meeting of the Section of Biology was held on Dec. 9, Professor Bashford Dean presiding. The following papers were presented:

'The Action of Alcohol on Muscle': F. S. LEE and W. SALANT.

'Instincts of Lepidoptera': A. G. MAYER.

'The Natural History of some Tube-forming Annelids': H. R. LINVILLE.

The first paper, presented by Professor Lee, consisted of an account of an investigation carried out by the two authors jointly, by very exact methods, pure ethyl alcohol being used, and isolated muscles of the frog in the normal and in the alcoholized condition being compared. It is found that the muscle which has absorbed a moderate quantity of pure alcohol will contract more quickly, relax more slowly, perform a greater number of contractions in a given time, and become fatigued more slowly than a muscle without alcohol. The effect is most pronounced in from one half to three quarters of an hour after the liquid has begun to be absorbed, and later diminishes. Whether the alcohol exerts this beneficial action upon the muscle substance itself or on the nerves within the muscle is not yet certain. The results allow no conclusion regarding the question whether the alcohol acts as a food or in some other manner. In larger quantities its presence is detrimental, diminishing the whole number of contractions, inducing early fatigue, and diminishing the total amount of work that the muscle is capable of performing, even to the extent of abolishing the contractile power entirely. In such quantities the action is distinctly poisonous. The after-effects of either small or large doses have not yet been studied.

Dr. Mayer reported upon a number of experiments designed to determine the nature and duration of associative memory in lepidopterous larvæ. In one series the larvæ were placed in a wooden box divided into two compartments by a central partition, which was pierced by a small opening. On one side of the partition was placed moist earth containing growing food-plants, while the other chamber was barren. The larvæ were placed in the latter and found their way through the opening to the food. Apparently they never learned the path to the food, but always wandered aimlessly about, never shortening their paths. When the food was removed, however, they rarely entered this side of the box, showing that it was the presence of the food that attracted them. Individual temperament is very well shown by the larvæ, for some quickly find the food, while others are much slower. This quickness is not due to superior intelligence, however, but is owing to the fact that these larvæ remain quiet for shorter periods of time than the slower ones. A number of experiments were made upon larvæ which devour only special kinds of leaves. These can be induced to eat sparingly of previously uneatable food if the sap of their proper food-plant be rubbed into the previously distasteful leaves. Similarly, they can be prevented from devouring their proper food-plant if the juices of uneatable plants be rubbed into the substance of the leaves. However, they can always be induced to bite at or devour any foreign substance if one allows the larva to commence eating its proper food, and then slides up in front of it a distasteful leaf, sheet of paper, tinfoil, etc. The larva will take a few bites of the foreign substance, but will soon draw back its head, snapping its mandibles with apparent disgust or aversion. Very soon, however, it recommences to eat in a normal manner. If, now, the foreign substance be presented to the larva at intervals of one and one half minutes or more, about the same number of bites is taken at each presentation, thus showing that the larva does not remember its disagreeable experience for this interval. If, however, the interval be about thirty seconds the larva will take fewer and

fewer bites of the disagreeable leaf, soon refusing it altogether. Here again individual temperament is shown in the reaction of larvæ in this respect. When spinning their cocoons the larvæ of *Samia cynthia* and *C. promethea* are geotropic, for if the cocoon be inverted soon after the completion of the outer envelope, the pupæ are sometimes found reversed also, and may thus be imprisoned in the cocoon; for the densely-woven (normally lower) end of the cocoon is probably impenetrable to the issuing moth. A series of experiments are now being tried to determine whether the peculiar coloration of male moths in dimorphic species is due to sexual selection on the part of the female. In the case of *Callosamia promethea* there appears to be none, for males are accepted even when female wings are pasted upon them, or when their wings or scales are entirely removed. In the case of *O. dispar,* however, there is a decided selection against males whose wings have been cut off; 57 per cent. of the perfect males succeed in mating with the females, while only 19 per cent. of the wingless males are successful. The peculiar coloration of the males in these cases has probably not been brought about through the agency of sexual selection on the part of the female, but may be due to race-tendency toward variation in a definite direction unchecked by natural selection.

Dr. Linville, in his paper, showed that the investigation of the habits of *Amphitrite ornata* and *Diopatra cuprea* brings to light many interesting adaptations. The first named lives in U-shaped tubes in sand and mud, access to food and water being possible at either end. Additions to the tube are made at the ends by the tentacles, which are continually drawing in small masses of sand. However, there is every indication that in this animal, where no occasion exists for a protecting tube, continued tube-building is merely incidental to food-getting. Food is brought to the mouth, which is always concealed, in the masses of sand and in water currents created by the inward-lashing cilia which thickly cover the tentacles. *Diopatra* lives in a tough, mucus-lined tube, with its deeper end bare and serving as an anchor, while its outer free end is studded with bits of shell and gravel. The animal may expose its anterior portion while searching for food and for suitable material to add to its tube. Observations made in the laboratory indicate that the animal chooses these materials by tactile sense-organs in the cephalic cirri. The particle is grasped between the palps or by the mandibles, or by both, and is then conveyed with a fair degree of precision to a place at the edge of the tube. During the construction, *Diopatra* periodically ceases to build in order to 'glue' the gravel and shell together. The mucous-secreting organs are pads upon the ventral surface near the head. These organs are brought in contact with the inner surface of the tube by long and vigorous contractions and expansions of the trunk segments. All or nearly all of the newly constructed portions are gone over in this way before the animal renews its search for new bits of gravel and shell.

Henry E. Crampton,
Secretary.

THE BOSTON SOCIETY OF NATURAL HISTORY.

An interesting exhibition of lantern slides of New England Birds was given by Mr. Reginald Heber Howe, Junior, at the meeting of December 4, 1901. Among the more interesting views shown was one of a phœbe's nest built inside a barrel, and a series taken on Seal Island, Maine, illustrating the breeding-grounds and nesting-tunnels of the Leach's petrel. A unique photograph was that of a male chestnut-sided warbler standing on the edge of its nest, in the act of removing excrement of the young. A number of views were shown of ospreys' nests, some built, as along the Maine coast, in trees by the shore, others, as commonly in Rhode Island, on cartwheels, elevated on the ends of poles for the use of the birds.

At the meeting of December 18, Mr. John G. Jack gave an account of forestry and grazing in the Bighorn Reserve, Wyoming. The great value of the forest for holding water, and thus insuring a permanent water supply, was pointed out, and the disastrous effects of forest fires were illustrated by a series of lan-

tern slides. Englemann's spruce and lodgepole pine were the chief timber trees noted on the reserve. An interesting view was shown of a valley, running east and west, on whose sunny southern slope grew the *Pinus flexilis*, while the cooler slope with the northerly exposure supported a growth of Englemann's spruce. A view of especial interest was shown, of a group of trees on whose sides were long and deep-worn scars, made years before and partially healed over, where elk had persistently rubbed their antlers while in the velvet.

Mr. Henry L. Clapp gave an account of school gardens in Europe and in this country. There are in Europe over 80 such gardens, from Sweden to Switzerland. The methods of laying out the gardens, preparing the soil, and planting of the flowers and vegetables by the children were explained by the speaker and illustrated by a fine series of lantern slides. Only recently has this practical and interesting method of teaching botany to children been introduced into this country, but the results have already been noteworthy, and more such gardens should be established for our own schools.

GLOVER M. ALLEN,
Secretary.

THE KANSAS ACADEMY OF SCIENCE.

THE Kansas Academy of Science held its thirty-fourth annual meeting at Iola, Kansas, on December 30 and 31, 1901, Professor E. Miller, of the Kansas State University, in the chair. While the meeting did not have an attendance equal to that of some former years, there was much interest manifested in its work and an unusually full program presented. Fourteen new active members were elected, and seven active members advanced to life membership. About forty papers, mainly on biological, geological and chemical topics, were presented, many of the more technical ones being read by title only.

A paper by Professor J. T. Lovewell, formerly chemist in Washburn College, Topeka, on 'Gold in Kansas Shales,' provoked considerable discussion. The author announced as the result of a very large number of assays, that gold in paying quantities exists in the vast beds of shales which cover such a large section of western Kansas. The chemists and geologists of the State University and many others have positively denied that gold exists in these shales. A warm discussion followed the reading of the paper, with the result that the Academy appointed a commission of three of its members to investigate the matter further, and to report at the next meeting of the Academy.

On Tuesday evening, December 31, President Miller gave the retiring president's annual address, choosing for his topic, 'The Growth of Science during the Nineteenth Century.'

'A New Plesiosaur' was described by Dr. S. W. Williston, of the State University. The remains of this animal, as well as those of many others, were discovered during the past season by Mr. Charles H. Sternberg, of Lawrence. Mr. Sternberg spent several months in the field, part of the time in the employ of a noted foreign museum, which thus obtained many of his most valuable discoveries. He read before the Academy an interesting paper on 'The Permian Beds of the Big Wichita Valley of Texas.' At the conclusion of his paper much interest was manifested in deploring the loss of these rapidly disappearing paleontological specimens to American institutions, and especially to those of Kansas. A lack of funds for employing explorers or buying the specimens is responsible for this condition.

The members of the Academy were shown every courtesy by the people of Iola, who interested themselves in showing their visitors through the vast industrial plants located there. These include several large zinc smelters, an acid manufactory, cement works, etc., all made possible by the vast field of natural gas which underlies this beautiful part of Kansas.

The following is a list of the officers for the ensuing year: President, J. T. Willard, of the State Agricultural College, Manhattan; First Vice-President, Edward Bartow, of the State University, Lawrence; Second Vice-President, J. A. Yates, of Ottawa University, Ottawa; Secretary, G. P. Grimsley, of Washburn Col-

lege, Topeka; Treasurer, E. C. Franklin, of the State University.

The next annual meeting will be held in Topeka.

D. E. LANTZ,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of January 6, 1902, about forty persons present, the following officers for 1902 were installed: President, Henry W. Eliot; Vice-Presidents, D. S. H. Smith, William E. Guy; Recording Secretary, William Trelease; Corresponding Secretary, Ernest P. Olshausen; Treasurer, Enno Sander; Librarian, G. Hambach; Curators, G. Hambach, Julius Hurter, Hermann von Schrenk; Directors, Amand Ravold, Adolf Alt.

On behalf of herself and a considerable number of other persons, Mrs. William Bouton presented to the Academy a collection of 633 butterflies mounted on Denton tablets, on condition that the collection should be made accessible to the public.

The following papers were presented by title:

'New Species of Plants from Missouri': K. K. MACKENZIE and B. F. BUSH.

'Revision of the North American Species of Triodia': B. F. BUSH.

Professor A. S. Chessin exhibited a gyroscope and explained how an accurately constructed and rapidly rotated gyroscope might be made to indicate the position of the meridian plane, the direction of the polar axis of the earth and the latitude of the place of observation, thus serving the purpose of the mariner's compass, but more accurately, because of the fact that the compass indicates the magnetic pole and not the true pole. The following formulæ pertaining to the subject were furnished:

$$T = \pi\sqrt{\frac{A + C_1 + A_2}{C\omega\Omega\cos\lambda}} \qquad T' = \pi\sqrt{\frac{A + C_1 + A_2}{C\omega\Omega}}$$

where T and T' are the durations of a complete oscillation of the gyroscope when its axis is made to remain in the horizontal and the meridian planes, respectively; ω and Ω the angular velocities of rotation of the earth and the gyroscope, respectively; A, A_1, A_2 and C, C_1, C_2 the equatorial and the axial moments of inertia of the gyroscope and the two rings on which it is mounted. From these formulæ the latitude (λ) of the place of observation is derived, namely:

$$\cos\lambda = \frac{T'^2}{T^2}.$$

Professor F. E. Nipher made a further statement concerning his results in the attempt to produce ether waves by the explosion of dynamite. He had obtained some results which seemed to show that magnetic effects could be thus produced. "There is apparently no doubt that great solar outbursts like the one which Professor C. A. Young saw at Sherman in 1872* produce enormous distortions of the ether. Why should it not be possible to reproduce this result? It goes without saying that large sun-spots may be slowly formed, without such ether disturbance; and certainly we can hardly expect to reproduce solar velocities. But terrestrial explosions do yield tremors and sound vibrations, and these lead to experimental difficulties. The nickel-silver coherer can be operated by the sound-waves from a tuning-fork. The coherer can be either opened or closed, by sound-waves, when the coherer is properly placed in a magnetic field. The same result may be produced by changes in the magnetic field, due to the slow approach of a horseshoe magnet. After the coherer circuit has been closed by a spark, the slow approach of a horseshoe magnet will often open the circuit, precisely as it does when the coherer has been closed by the magnet held in a position of reversed polarity. When the magnet fails to open the coherer circuit, the cause is either a too rapid approach, which causes the coherer to close by reversal of magnetic polarity, or a wrong presentation of the magnet, which confirms the condition produced by the spark discharge. The conditions under which experiments are made as yet, with the jarring due to the street traffic and the explosions, and the changing magnetic field due to the electric cars, have proven to be a source of some perplexity. It throws some doubt

*'The Sun,' p. 156.

upon the results reached. However, there seems to be a residual effect which cannot thus be accounted for, and it may be due to an ether displacement. This matter is being carefully studied, and it is intended to use more violent explosives."

WILLIAM TRELEASE,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

AN AMERICAN GEOGRAPHICAL SOCIETY.

As has been announced, the next meeting of the International Geographical Congress is to be held in Washington, D. C., in 1904. It must be apparent, I think, to every one familiar with the status of geography in America, that we are not prepared for such an invasion, and that a better organization of our geographical ranks is highly desirable.

There are now at least ten geographical societies in the United States. How many more there are in other parts of the two Americas I am not informed. Each of these societies is a local organization and there is no tangible bond of union between them. It needs no argument to show that some form of cooperation or of union between these various societies is much to be wished, not only that we may make a creditable showing at the coming meeting of the International Congress, but what is much more important, in order that mutual assistance may be had, and the science of geography advanced in a more efficient way than is practicable at present. This matter is not new, and at the risk of seeming to assume undue responsibility, I venture to state a plan of reorganization which embodies ideas gathered from various sources.

My thesis is: There should be an American Geographical Society having for its territorial limits the New World. The aims of this society should be in the main threefold:

1st. The holding of a general meeting each year, preferably during convocation week.

2d. The publication of an illustrated monthly magazine, devoted to geography in its widest aspects.

3d. The promotion of geographical exploration and research.

In reference to the first of these aims, I need not enlarge on the desirability of an annual meeting at which the results reached by various students of geography may be presented and discussed, and acquaintances made or renewed, since abundant justification for such a course is known to every one, from the success that has attended the annual meetings of several national and international scientific organizations during the past decade. Geographers certainly need to know their fellow workers as much as geologists, chemists, etc., need to know each other. This would be one of the chief results of an annual meeting of geographers, held perhaps at the same time and place as the annual winter meeting of the Geological Society of America.

The greatest gain to be expected from the proposed reorganization lies in the second of the aims to be fostered by the new society, namely, the publication of a strong, attractive, well-illustrated monthly magazine, in the place of the several publications now issued by existing societies. Some of the reasons for this are: The saving of expense in editing, and in duplication, especially of news items, reviews, etc.; concentration and ready reference. The concentration of American geographical literature would be a blessing to future generations, in view of the fact that complete files of the present publications are not readily accessible, and to find all of them in one library is seldom possible. With a central bureau of publication, also, it is to be hoped that the standard of the articles published would be higher. While the expense of a monthly magazine representing the interests of all classes of geographers, and well edited and well printed, would perhaps be greater than that of any one of the single publications referred to, it would be much less than all of them combined. It would also, I venture to assert, reach a wider audience than all of the publications combined which it would replace. Such a magazine would place American geography in a far more favorable light than it now enjoys, in the eyes of the geographers of other continents.

While a few of the existing societies have assisted in geographical research, their efforts

have been local and the results attained, while creditable, have not been such as could be legitimately expected from a stronger and more widely extended organization. With all geographers in America united, influence in favor of exploration could be brought to bear upon legislative bodies which would command attention.

PLAN OF REORGANIZATION.

To attain the desirable ends referred to above, the following plan for uniting the existing geographical societies into one organization, with power to increase its membership and broaden its efficiency, is proposed for discussion:

Let each of the existing societies become a section of the new organization to be known as the American Geographical Society. Each section to manage its own affairs, independently, have its own officers, its own property, etc., but pay a sum, in proportion to its membership, in support of the magazine to be published by the united sections.

All members of the various sections to be fellows of the larger organization, and at their annual meeting to elect a president, secretaries, treasurer and editor. The president of each of the various sections to be ex officio vice-president of the main society.

The various sections to choose their own names, but it is to be hoped these names would be geographical, as for example, Boston Section, New York Section, Washington Section, San Francisco Section, etc., of the American Geographical Society. Such a broadening and enlargement of aims would be a compliment to the Society now bearing the name which it is desirable should be given to the representative Society of the two Americas.

The arguments for a truly American geographical society are far greater than I have attempted to show. The objections to the plan outlined seem to refer entirely to local pride or, more accurately, local self-interest. That the existing societies should be proud of the results they have attained and love their present methods is not only natural, but commendable. A broader view, however, must convince one that each local society by union with all other similar societies in America, without losing its own individuality, would bring to itself renewed strength and vigor.

My aim in presenting this outline of a method by which all students of geography in America may be induced to cooperate and mutually assist in enlarging the boundaries of geographical knowledge, is to invite discussion. I am sure that the editor of SCIENCE will give space for the expression of the opinion of any one in this connection. I wish especially to invite the Council of each existing society to discuss this matter and express its views. If we can arrange for a meeting of delegates from each society, a mutual agreement beneficial to all can no doubt be reached. This should be done in time to effect a reorganization before the convening of the International Geographical Congress.

ISRAEL C. RUSSELL.

ANN ARBOR, MICH.,
Jan. 13, 1902.

THE INTERNATIONAL CENTRALBLATT FOR BOTANY.

As we have already noted the president of the *Association Internationale des Botanistes* has appointed the following American editors for the *Botanisches Centralblatt:*

D. H. Campbell, Stanford University, California, 'Morphology.'

C. J. Chamberlain, University of Chicago, 'Cytology.'

D. T. MacDougal, New York Botanical Garden, 'Physiology.'

G. T. Moore, Department of Agriculture, Washington, D. C., 'Algae, Lichens, Archegoniates' (systematic).

D. P. Penhallow, McGill University, Montreal, 'Paleobotany.'

H. von Schrenk, Washington University, St. Louis, Mo., 'Fungi (systematic) and Vegetable Pathology.'

Wm. Trelease, Missouri Botanical Garden, St. Louis, Mo., 'Phanerogams' (systematic).

For the coordination of the editorial work, the two editors last named have been asked to serve respectively as secretary and chairman of the American Board.

Professor William Trelease, chairman of the Board has sent out the following directions, which we quote as of interest to all workers in science.

In order that the *Centralblatt* may be given the greatest possible value for American botanists and that the least possible delay may be experienced in securing the publication of abstracts of American papers, the authors of such papers are requested to promptly send copies of the same (marked 'for review,' if convenient) to the editor in charge of the subject dealt with in each paper, or, if authors' separates are not available, to call the appropriate editor's attention to the paper.

Each editor is requested to make a regular examination of current journals, proceedings of societies, etc., for papers dealing with his subject, so that occasional failure to receive an author's separate may not deprive the users of the *Centralblatt* of prompt reviews of all papers published in this country. In case an editor has not regular access to any specified serial publication, the chairman will keep him informed as to its contents, if asked to do so. Each editor is requested to consider the subject assigned to him in the broadest possible sense, and, in case of a paper doubtfully lying in his field, to err on the side of noticing it rather than in the other direction, or to specifically refer it to the editor to whom, in his judgment, it should go, or to the chairman of the board.

The management of the *Centralblatt* asks that abstracts (which may be in English), rather than commendatory reviews, be prepared; that the more important publications be first noticed, title and place of publication of current papers not reviewed being likewise sent in; and that attention be given to *quality, promptness* and *brevity,* in the sequence indicated, in the preparation of abstracts.

The chairman of the American Board suggests, with endorsement of the preceding paragraph, that his colleagues adopt the general form and marking for printers of the accompanying model,* in the heading of abstracts, following the Madison rules for abbreviations when such are considered necessary; that names of all new genera, species and varieties (which, like latinized names in general, should be italicized) be included in abstracts of systematic papers; that especial care be given to legibility, punctuation and the spelling of geographic and scientific names and technical words, and that 'copy' and entries for papers not reviewed be sent to the chairman regularly at the end of each week, a memorandum of postage and other necessary expense being kept and sent in at the end of each quarter year.

The editor of the *Centralblatt* desires to have each abstract signed by the person who prepares it, and, subject to approval and correction of reviews before transmittal to the chairman, each editor has the privilege of assigning any papers in his department to suitable persons, in case he does not wish to abstract them himself.

* CAMPBELL, D. H. 'On the affinities of certain anomalous dicotyledons.' (American Naturalist, 36: 7–12. *f. 1–2.* Jan., 1902.)

SCIENTIFIC NOTES AND NEWS.

AT a recent meeting of the American Academy of Arts and Sciences of Boston, the following were elected: E. B. Wilson of New York, as associate fellow; Julius Hann of Vienna, E. R. Lankester of London, V. A. H. Horsley of London, F. Delitzsch of Berlin, and S. R. Gardiner of Sevenoaks as foreign honorary members.

JOHNS HOPKINS UNIVERSITY will celebrate on February 21 and 22 its twenty-fifth anniversary, when President Remsen will be formally inaugurated. Dr. D. C. Gilman, president emeritus, will deliver the commemorative address in the afternoon of Feb. 21. This will be followed by an official reception to the delegates, and at eight o'clock in the evening there will be a general reception. President Remsen will make his inaugural address on Feb. 22, in the afternoon. In the evening the annual banquet of the Alumni Association will be held.

THE medals and funds of the Geological Society of London will this year be awarded as follows: The Wollaston medal to M. Friedrich Schmidt of St. Petersburg, the Murchison medal to Mr. F. W. Harmer, and the Lyell medals to Mr. R. Lydekker and Professor Anton Fritsch, of Prague; the Wollaston fund to Mr. L. J. Spencer, the Murchison fund to Mr. T. H. Holland, the Lyell fund to Dr.

Wheelton Hind, and the Barlow-Jameson fund to Mr. W. M. Hutchings.

Dr. Eugen Warming has been appointed director of the Geological Survey of Denmark.

Professor J. H. Marshall, who has recently been engaged in archeological researches at Athens, has been appointed director-general of the Archeological Survey of India.

We learn from the *American Anthropologist* that a committee has been appointed at the instance of the Société d'Excursions Scientifiques, to solicit funds for the erection in Paris of a monument in honor of the late Gabriel de Mortillet. Favorable response is being made, and the names of a number of American subscribers appear in the printed list distributed by the committee. M. Louis Giraux, 22 rue Saint Blaise, Paris, is the treasurer.

We learn from *Nature* that a medallion bust of Sir George Airy is to be placed in the northeast wall of St. Alphage Parish Church, Greenwich, by his daughters. The bust has been copied from the one in the Royal Observatory, Greenwich.

Dr. William LeRoy Broun, president of the Agricultural and Mechanical College of Auburn, Ala., died on January 23.

Professor Emil Scheffer, a chemist, died at Louisville, Ky., on January 22, at the age of ninety years.

Dr. Hugo von Ziemssen, the eminent German pathologist, professor in the University at Munich, died on January 20, at the age of seventy-two years.

Mr. Charles Roberts, a British surgeon and the author of contributions to anthropometry and natural history, died on January 8.

The annual meeting of the board of regents of the Smithsonian Institution was held on January 22. There were present Chief Justice Fuller, chancellor, in the chair; William P. Frye, president pro tempore of the United States Senate; Senator S. M. Cullom, Senator O. H. Platt, Senator F. M. Cockrell, Representative Robert Adams, Jr., Representative Hugh A. Dinsmore, Dr. J. B. Angell, Richard Olney, George Gray, J. B. Henderson, Dr. Alexander Graham Bell and Secretary Langley. Dr. Andrew D. White, ambassador at Berlin, and Representative R. R. Hitt were unable to be present. The secretary presented his annual report for the fiscal year ending June 30, 1901, of which we hope to give some account when it has been published. The needs of the United States National Museum were considered and a resolution was adopted providing for a committee, consisting of six members of the board, whose duty it shall be to represent to Congress the pressing necessity of additional room for the proper exhibition of specimens belonging to the National Museum, and of additional appropriations to carry on the work of the museum. The chancellor appointed as members of the committee Senators Platt, Cullom and Cockrell and Representatives Hitt, Adams and Dinsmore.

It is said that M. de Witte, the Russian minister of finance, has drawn up a decree making the metric system obligatory in Russia. The decree is now under the consideration of the Imperial Council.

Major Ronald Ross announces that Dr. Dutton has found a new kind of parasite, which causes fever in human beings. The parasite is said to be like the one which causes the fly disease among horses in South Africa.

The Department of Superintendence will hold its annual meeting at Chicago on February 26 and 27 under the presidency of Mr. G. R. Glenn, state school commissioner of Georgia. Among the papers to be read and discussed are: 'Obstacles to Educational Progress,' Paul H. Hanus, professor of theory and practice of education, Harvard University; 'The Danger of using Biological Analogies in Reasoning on Educational Subjects,' Dr. W. T. Harris, U. S. Commissioner of Education, Washington, D. C.; 'The High School as the People's College versus Fitting Schools,' Dr. G. Stanley Hall, president of Clark University, Worcester, Mass. Evening addresses will be made by Dr. F. W. Gunsaulus, president of the Armour Institute, Chicago, Ill., and Dr. Charles W. Dabney, president of the

University of Tennessee, Knoxville, Tenn. The National Society for the Study of Education, of which President Nicholas Murray Butler of Columbia University is president, will meet in conjunction with the Department of Superintendence on February 27 and 28.

THE ninety-sixth annual meeting of the Medical Society of the State of New York was held at Albany on January 28, 29 and 30, 1902, under the presidency of Dr. Henry L. Elsner of Syracuse.

THE conference of science teachers, which has been arranged in recent years by the Technical Education Board of the London County Council, was held on January 9 and 10, with about 400 teachers in attendance.

THE twenty-third annual meeting of the German Balneological Congress will be held this year at Stuttgart from March 7 to 11, under the presidency of Professor Oscar Liebreich.

THE eleventh Congress of Russian Naturalists and Physicians was opened at St. Petersburg on January 2. We learn from *Nature* that the number of people taking part in the Congress was very large, more than 3,250 members' tickets having been taken on the day of opening. The Minister of Public Instruction has given a sum of 500*l.* to defray the expenses of the Congress, and both the municipality of St. Petersburg and the university have contributed large sums for the same purpose. At the first general meeting of the Congress, the president (Professor Menschutkin) spoke about the foundation of a Russian Association for the Advancement of Science, which would hold regular congresses every year. This proposal was accepted by a congress held eleven years ago; but the Ministry of Public Instruction was hostile to the idea, and only now the new Minister, General Vannovsky, has agreed not to oppose it. At the same general meeting Professor S. M. Lukianoff delivered an address on the limits of cytological research under normal and pathological conditions, in which he endeavored to establish the limits of psycho-physiology; and Professor N. A. Umoff delivered a brilliant address on a physico-mechanical model of living matter.

PLANS are being made for the establishment of a national institute of hygiene in Spain. The State has offered a site for the building, and it is hoped that sufficient funds will be raised by public subscription.

THE *British Medical Journal* states that an institute for the application of the light treatment has been established in Vienna. At a recent meeting of the Medical Society of that city Professor Lang announced that, in conjunction with a number of medical practitioners and philanthropists, he had founded an institute on the model of that of Professor Finsen at Copenhagen. The institute would be to a certain extent under the control of the municipality. Among the founders is the Emperor, who has contributed 10,000 crowns.

MR. CHARLES T. HAM has presented $5,000 to the Rochester Academy of Medicine, to be used to further medical research.

PROFESSOR J. B. SMITH, New Jersey state entomologist, expects to ask the legislature next week to appropriate $10,000 for the investigation and extermination of the New Jersey mosquito.

WE called attention recently to the Woman's Table at the Naples Zoological Station, maintained by a number of women's colleges and individuals. Those desiring further information in regard to the conditions under which the table may be occupied should address the secretary, Miss Cornelia M. Clapp, Mt. Holyoke College, South Hadley, Mass.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. ANDREW CARNEGIE and the descendants of Peter Cooper have respectively given $300,000 to Cooper Union, New York City, doubling the gifts made by them to the Union three years ago. The total income will now be about $90,000, which will not enable the trustees to greatly enlarge the work of the Union, but there will no longer be a deficit, and the efficiency of the work will be increased. It is said that the entire building will now be used for the work of the Cooper Union, that the salaries of the teachers will be somewhat increased, and that the work in physics and electrical engineering will be enlarged.

Chancellor James R. Day, of Syracuse University, has announced that Mr. John D. Rockefeller has given $100,000 to the university endowment fund. This insures the raising of $400,000 to meet the offer of Mr. John D. Archbald, of New York, to double that amount. Among the new buildings that will be erected will be a biological laboratory.

Through the death of Mrs. Charlotte L. Sibley Phillips Exeter Academy will receive $50,000 and the Massachusetts Historical Society $100,000.

The University of Aberdeen has received £25,000 from Lord Strathcona and £30,000 in smaller subscriptions.

Sir W. O. Dalgleish has given £10,000 to St. Andrew's University, half of which is for the new building of the Medical School.

The Drapers Company has voted a donation of £30,000 to the new University of London.

At a meeting of the executive committee of the Carnegie Trust held in Edinburgh, the secretary and treasurer submitted their reports for the period ended December 31, 1901, showing that fees have been paid by the Trust to 2,441 students, amounting to the sum of £22,941. It was arranged to hold the annual meeting of the trustees in London, at which the first report of the executive will be submitted.

The second annual court of governors of Birmingham University was held on January 8. Mr. Chamberlain, the chancellor, made an address describing the progress of the University. Plans have been drawn up for buildings to cost about $5,000,000, and three groups, to cost about $1,500,000, will be erected with the money that has been subscribed. As has been already reported, the Birmingham City Council had made a grant equal to a halfpenny in the pound on the borough rate, producing £5,-750 in the financial year, and directed that a similar grant should be provided for in its annual estimates until it should otherwise order. The Staffordshire County Council had similarly identified itself with the aims of the University by making a grant of £500 a year for five years, in aid of the School of Mining and Metallurgy.

About a year ago Mr. H. Melville Hanna founded in the medical department of Western Reserve University a research fellowship for the promotion of original work in medicine, especially in physiology and pathology. Applications for the fellowship are now invited. The income of the fellowship is about $600 a year. It is tenable, in the first instance, for one year, but a fellow who has done exceptionally good work may be reappointed for a second term. All communications should be addressed to Dr. G. N. Stewart, professor of physiology, or Dr. B. L. Milliken, dean, medical department of Western Reserve University.

Professor Edmund J. James, professor of public administration in the University of Chicago, has been elected president of Northwestern University.

Dr. R. E. Jones has resigned from the presidency of Hobart College.

Dr. Julius Sachs, head of a well-known preparatory school in New York City, has been elected professor of secondary education in Teachers' College, Columbia University.

At the January meeting of the board of trustees of Syracuse University, the following changes in the faculty of science were announced: Associate Professor H. Monmouth Smith was made full professor of chemistry. Instructor Edward H. Kraus was made associate professor of mineralogy; W. M. Smallwood, professor of biology in Allegheny College, was elected associate professor of zoology. Professor Smallwood is now on leave of absence, doing graduate work in Harvard University. He will assume the duties of his new position in September next.

At Columbia University Mr. John Cabor, Jr., M.E., has been appointed assistant in the department of physics, to succeed George B. Pegram, promoted, and Mr. Wilson E. Davis, A. B., assistant in the department of mining.

Dr. W. H. Thompson, Dunville professor of physiology, Queen's College, Belfast, has been elected to the chair of institutes of medicine (physiology and histology) in the Royal College of Physicians of Ireland, rendered vacant by the resignation of Professor J. M. Purser.